Report of American Chemical Society Meeting

CHEMICAL & METALLURGICAL ENGINEERING

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Lessons from the Last A. C. S. Meeting

THE American Chemical Society is big; it has now over 15,000 members. Its meetings are so well attended that the problem of hotel accommodation becomes difficult even in the greatest cities. The same holds true in regard to convenient railway accommodations. The number and variety of papers read are no less than bewildering. At the St. Louis meeting last week there were 266 papers on the program, and if we were to include the additional addresses brought out in the discussions which followed these presentations the number would be materially increased.

Immensity of this sort brings certain inconveniences in its train. The allotment of papers to the various sections is sometimes a difficult matter and the lack of publication of the papers or even of abstracts of them before the meeting makes it hard for a member or visitor to determine which he will hear. Titles are occasionally misleading.

And yet proposals for changes in procedure meet with objections which are at once sincere and worthy of consideration. The thing most needed, in our opinion, is that a short abstract of each paper be printed under its title in the program. Secretary PARSONS says this would be possible provided a hard and fast rule were made to the effect that no paper be admitted unless a digest of not over a certain number of words were forwarded to him by the author before a given date. The provision of exceptions to the rule would make it of no effect because authors, as a general rule, will not abstract their own papers if they can avoid it; and again, authors are seldom good abstractors of their own works. We understand that such a rule exists in the American Institute of Chemical Engineers, but we also understand that even in this comparatively small organization it is the secretary who really does the work. To abstract 266 papers on such a variety of subjects would require a whole congregation rather than one or more Parsons!

The question is raised whether the number of papers is not too great. Many would be better printed than read and in such a form they would be more useful. But at least 75 per cent of those presented will never see the light of print and this is the only chance that anyone but the author will ever get to see them. The mere record of such contributions on the programs is of great value, for it tells by whom research is in progress. We think it would add to the value of the record if the academic or technical occupation of each author were also given as well as his address. If we had our way about it, we should insist on the requirement that every author furnish an abstract of his work presented. In the end it would be of marked value to the contributors.

The unanswerable argument in favor of the large number of papers is also made that it is wholesome to invite chemists to tell of what they are doing. Every effort should be made to encourage this. We have been especially impressed at this meeting with the frank contributions from the laboratories of industrial establishments which are engaged in lively competition. We have not reached full measure in this respect as yet—or anything like it—but the tendency is growing among their scientific men. As mentioned elsewhere, it has been proposed that the general meetings of the Society be restricted to one instead of two each year. Along with this it is suggested that sections in neighboring states have joint meetings one or more times in the interim. The convenience of this is offset by the possibility that such a procedure might make for sectionalism, which is to be avoided at all hazards, and again, especially in regard to industrial chemistry, it is important that those engaged in it get a chance to exchange views with their colleagues from all over the country.

We wish it were possible for a larger number of professors of chemistry to attend these meetings. During a short visit to the dye section on Wednesday morning there were discussed and elucidated the following subjects: The application of certain dyes for photographic sensitizing. This comparatively new subject is pregnant with possibilities. Its great use, of course, has been in army air work, but owing to the much clearer delineation which certain dyes provide, it promises much in the field of astronomy as well. New tests for the purity of intermediates were proposed, the merits of formic acid in the dyeing industry were presented and the reasons why, and an illuminating presentation of the action of synthetic dyes in chemicotherapy was given. We believe that young men should be taught chemistry as a thing of today and alive rather than as a thing to be groaned out of text books and boned over. These meetings emphasize the vitality of the subject.

The sections continue to multiply. The dye section is growing strong, the rubber division is finding itself, the leather chemistry section is started and it deserves to succeed. Leather manufacturers have been singularly backward in furthering the science of tanning—with notable exceptions—and we understand there are still a number of influential old leatherbacks who feel that it is a great mistake to wander away from the regular leather association. Of course there is the danger that they may get some new notions and come back talking about colloid chemistry! In fact, one of the leading leather chemists read a paper at the Colloid Symposium on "Vegetable Tanning as a Colloid Chemical Process." To the good old practical tanner who thanks GOD that he is not a theorist such a title must sound like the hissing of a snake. The division of industrial and engineering chemistry is almost overburdened with variety. The few isolated papers on

metallurgy seem almost lost in the shuffle and it seems fair to question whether the subject of metallurgy is properly within the domain of the Society or not. The successful Symposium on Cellulose Chemistry has led to the proposal that a cellulose section be organized, and we expect to see the plan mature.

The St. Louis meeting was successful.

Extrusion Or Diffusion?

SINCE Messrs. RAWDON and SCOTT have given considerable attention, in their paper on the Microstructure of Iron and Mild Steel at High Temperatures, reprinted on page 787 of this issue, to Dr. HOWE'S ideas regarding the expulsion of excess insoluble constituent to the boundaries of austenite grains, a brief consideration of this theory may be interesting. In his recent book on "The Metallography of Steel and Cast Iron," he cites the various following facts to support his proposed mechanicalized transport of exotics, which might be described as an "elbowing" effect:

First, those constituents appearing as needles in Widmanstättian bands are in that arrangement due to an expulsion to the octahedral cleavages of austenite rather than to an inherent crystallinity of the cementite or ferrite itself. The former is described as being orthorhombic, assuming the form of a rhombohedron, while OSMOND and CARTAUD find sublimed crystals of both α and β iron to be cubic.

Second, excess constituent will be found at the former location of slip bands after annealing overstrained metal.

Third, slag particles are at boundaries because crystals of austenite growing from a mother liquor *push* them away.

Fourth, since slag is posited by "elbowing," its later frequent accompaniment of ferrite (or cementite) borders is caused by a like action.

Fifth, ferrite (or cementite) is *extruded* to the borders of austenite crystals upon cooling through the critical range, thus forming the well-known network shown in microphotographs.

Sixth, excess constituent is by the same action extruded to all exposed surfaces, whether outer skin or inner cavities.

Presumably Dr. HOWE would be quite willing to admit that there is another way to explain the migration of excess constituent, rather than by an elbowing effect; all of these reasons of his, with the exception possibly of the last, might be well explained otherwise. In other words, one alternative hypothesis is that excess constituent migrates to preformed nuclei of the same substance, much as a crystal grows in aqueous solution. The movement of substances through solution (solid or liquid) is matter of diffusion to maintain equilibrium; that is, continual dissolution at one place of low concentration and redeposition in another place at higher concentration rather than a mechanical transportation of the substance *en masse*.

His statement that internal cavities are lined by ferrite in hypo-eutectoid and cementite hyper-eutectoid steels is rather a poser to one who does not accept his idea of elbowing effect. RAWDON and SCOTT'S experiments showing a pronounced decarbonization when heating either grade of steel *in vacuo*, leave one somewhat bewildered by the imposing evidence cited by Dr. HOWE showing migration of cementite to superfices during heating. On the other hand, the proponent of diffusion might ask him to cite some instance where austenite has been able to transport, bodily, a slag inclusion, or some *insoluble* constituent. Certainly the grain boundaries in Figs. 1, 2, 3, 6 and 8 appear to be entirely independent of the black spots, presuming them to represent non-metallic inclusions. If austenite will elbow out cementite or ferrite, as the case may be, it certainly ought to elbow out a particle of sulphide or any other foreign matter that might be there. On the other hand, diffusion is powerless to move an insoluble substance. So that the real test of the problem would be to discover some sample wherein an insoluble constituent has been moved.

Instances of this sort are possibly totally lacking in published literature. Dr. GIOLOTTI remarked that unpublished researches prove to his own satisfaction that slag is not moved after heat treatment. Dr. STEAD has written, in describing some of his experiments on the diffusion of phosphorus, that after long-time annealing he was able to break up all dendritic structure and to equalize phosphorus throughout the metal, but he states explicitly that even then non-metallic inclusions were not changed in location.

The Greater Circulation of Chemists

EVERY spring and fall a thousand or so American chemists, representing the widest range of interests and thought, have shown their professional spirit by setting aside their normal activities for a week and attending the semi-annual meetings of the American Chemical Society. About one-fourth of this thousand have manuscripts, giving the findings of their laboratories, which they are scheduled to talk over hurriedly in a time allowance varying usually but little from ten minutes. It would be superficial to conclude that the motive of the remaining three-fourths in making the journey to the convention city was primarily a desire to listen to the other fourth, especially when it is considered that those of the papers presented that are considered important will soon be published.

It might be thought that papers of insufficient consequence to deserve space in the journals should be barred from taking up the precious minutes of the meeting. This would be consented to without argument, were it not for the fact that many points are brought out in the discussions which prove to have great value and would never have been brought to wide attention if it had not been for the suggestion found in some minor-grade paper. However, it is in this very important aspect that the treatment of papers presented before the American Chemical Society is lamentably weak. Discussions are not fostered by giving counter-opinion time to formulate and be presented. Practically no provision is made for light on the other side in the papers published and it is left to each individual reader to furnish his own salt by way of condiment with what he feeds his brain.

It may be said that to a limited extent, after the sessions close, the congregations in the lobby, halls, dining rooms, take up in their conversation an interchange of opinion on papers just delivered along with all sorts of other topics of interest to chemists. It is this phase of the meeting that has the greatest value

and more than repays for all expenditure of time and money for personal attendance. The acquaintance, the critical opinions, the ideas that everyone gains or should gain from such a congregation of the highest chemical talent is of the greatest value. It is not the attendance of the meeting as a programmed performance that counts, but the greater circulation of chemists in their own channels.

The precedent set by the Harvard Graduate Chemists Association in scheduling a luncheon on the Tuesday of each meeting week was immediately followed by the alumni of Chicago, M.I.T., and Pennsylvania. This will be very beneficial as well as enjoyable. It will give the alumni chemists an opportunity to get acquainted with those who preceeded or followed them in the old labs at their alma mater.

Byproduct Coke Passes Beehive

AMONG the things for which the year 1919, now happily passed into memory if not into happy memory, will be remembered is that in that year the output of byproduct coke in the United States first exceeded the output of beehive coke, the preliminary figures of the United States Geological Survey, just issued, showing production of 25,171,000 net tons of byproduct coke and 19,650,000 tons of beehive coke, making a total of 44,821,000 net tons, the proportions being 56 per cent byproduct and 44 per cent beehive.

In one sense the passing of beehive coke by byproduct coke in 1919 was a lame performance, in that the byproduct output, while exceeding the beehive product of 1919, fell far short of equaling the beehive output in numerous preceding years. The beehive record is 35,364,224 tons produced in 1916. From another viewpoint the performance was particularly creditable, for 1919 was a year of light demand for coke, and byproduct coke showed its stamina by declining only 3 per cent in tonnage from 1918, when beehive production slumped off by 36 per cent.

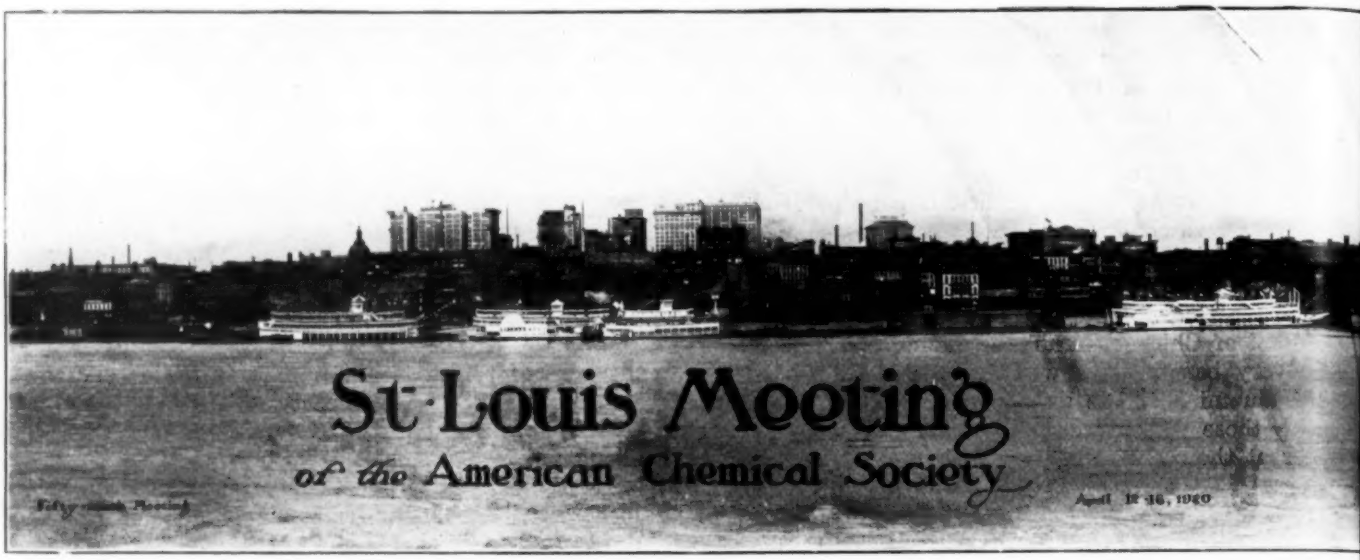
Whether the rise in byproduct coke manufacture in the United States should be considered slow or fast depends on the viewpoint. It has been fast considering that the present capacity is double the capacity of five years ago and more than quadruple the capacity of ten years ago. On the other hand, the merits of the byproduct process were being preached in vain more than a quarter century ago, although the arguments were backed up by some substantial figures drawn from experience abroad.

It is safe to say, at any rate, that byproduct oven building was backward for a time and then was quite in the forefront. This is what would naturally be expected, for the burden of doing the thing rested very largely upon the iron and steel industry, seeing that in smelting its ores that industry consumes 80 per cent or more of the coke produced in the country. Now, the iron and steel industry is one that has grown rapidly in tonnage, requiring constant reinvestment of its profits, and it has also had occasion to make many improvements in methods and appliances, this also requiring much capital. Accordingly the industry has always had occasion to invest more money than it had, and something had to wait. The industry is highly competitive, in that while all may sell at much the same price—the present exception is a good test of the general rule—the concern that lags behind others in making improvements is likely to get lost. Hence when byproduct coke oven building eventually became "the thing" the work was prosecuted rapidly. It was not until 1900 that byproduct coke production crossed the million ton mark, while in 1907 it crossed the five million ton mark. In 1912 more than 10,000,000 tons was produced, while in 1917 more than 20,000,000 tons was made—22,439,280 tons, to be precise. Last year's production, as noted above, was about 25,171,000 tons, and the Geological Survey estimates the capacity, at full rating for each plant, at 39,500,000 tons at the beginning of the present year. Assuming that 85 per cent of rating is a fair expectation of actual output, this makes the real capacity rating at the beginning of this year about 33,600,000 tons. Plants being built should raise this to 36,800,000 tons.

Nearly all the byproduct coke made is used in the iron blast furnace, only limited tonnages going to the foundry and for miscellaneous uses. The blast-furnace requirements may be estimated approximately. The coke furnaces may be taken at about 45,000,000 gross tons of pig iron a year. The coke consumption per ton of pig iron has been reported for a number of years, decreasing to 2,252 pounds per ton in 1915 and then increasing thereafter, chiefly, it appeared, on account of coke turning to poor quality during the war. On account of its regularity, byproduct coke shows somewhat better performance than beehive coke, and 2,200 pounds is a conservative estimate for future performance. This would mean 49,500,000 tons of coke to operate all the coke blast furnaces, and of this the byproduct ovens could furnish, according to the estimate, 36,800,000 tons, or 74 per cent. Considering simply the total coke, and taking blast-furnace consumption as 81 per cent of the total consumption, the entire coke requirements would be 61,000,000 tons, with, say, 37,000,000 tons byproduct and 24,000,000 tons beehive, the proportion being 60 per cent and 40 per cent. This leaves quite a field still for the beehive coke oven, even though there would be a 32 per cent decrease from the 35,464,224-ton record made in 1916.

Cogitations on Colloidal Theories

THE colloid symposium held at the meeting of the American Chemical Society in St. Louis brought forth several statements which give food for contemplation to even those who are uninitiated in the mysteries of the general nature of colloids. It seems that the ideal of the soap chemist is to obtain a bar of water that would stand alone. MARTIN H. FISCHER says that he likes ions, but there are not an awful lot of them around. A discovery by JOHN ARTHUR WILSON that the standard methods of tannin analyses approved by the American and European leather chemists' associations were found to give results which in scientific practice were from 50 to 250 per cent out of the way was as startling as it is true. We expect to hear from makers of various extracts that Mr. WILSON'S conclusions are soused and tanned with error; but against this is the fact that he has put them into practice and they work. With a start like that made by Mr. WILSON it will be a grand thing all around if American tanners in general take a hitch in their belts and go in quest of greater scientific control. Truly the research and application of colloid chemistry is to bear an even greater economic influence on the chemically controlled industries.



Report of the Events of the Convention—Review of a Selection of Addresses, of the General Meetings and Divisions of Industrial Chemists and Chemical Engineers, Sugar, Leather, Dyes, Physical and Inorganic Chemistry

THE fifty-ninth meeting of the American Chemical Society was held in St. Louis, April 12 to 16, inclusive. About 1,000 members attended in spite of the interference brought to transportation by the railway operators' strike. The program contained 266 papers, of which notes from some of the more important are presented in this report. The description of the industrial excursions and the report on the rubber section could not be included in this issue, but will be published later.

The General Meeting

The general meeting of the Society was held at Hotel Statler at 10 o'clock on April 11. The Hon. HENRY W. KIEL, Mayor of St. Louis, made the address of welcome, to which response was made by President NOYES. Dr. ERNEST SOLVAY of Brussels was then elected to honorary membership in the Society and memorial resolutions on the death of Prof. ALFRED WERNER of Zurich, also an honorary member, were presented and adopted. The Hon. E. P. COSTIGAN of the U. S. Tariff Commission was scheduled to speak on "The Chemical Industry and Legislation," but duties at Washington prevented him from attending. In his place PAUL BROWN, editor of *America at Work* of St. Louis, spoke on "The Physical Basis for the Economic Development of the Mississippi Valley."

Mr. Brown proved an able speaker and the only possible conclusion to draw from his remarks is that St. Louis is the navel of the world. He said that the Mississippi River was now under control and that the tendency of future traffic will be from north to south instead of from west to east, on the ground that there is a greater variety of products by longitude than by latitude. The use of the great river is only beginning. He observed that the North has a great lesson to learn from the South in the community spirit in farming which has developed there, while Northern farming has tended to encourage individualism. He noted also that the center of population of the United States, which is but 125 miles from St. Louis, is also the center of the production of raw commodities.

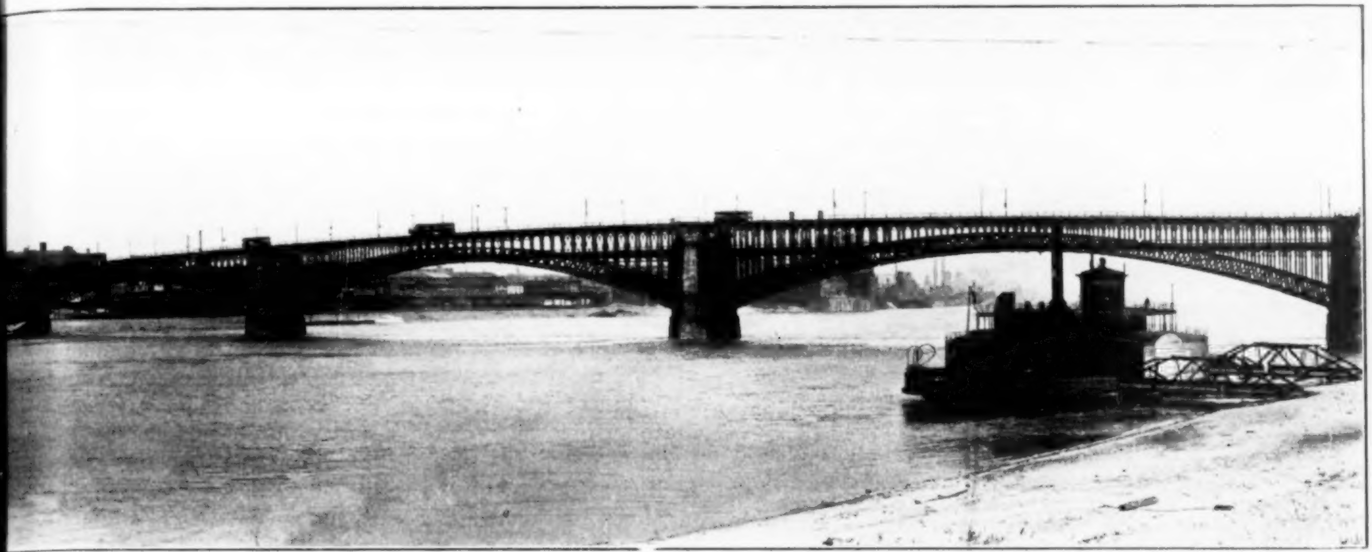
The second general address was by Dr. CHARLES H. HERTY, editor of the Society's *Journal of Industrial and Engineering Chemistry*, on "Victory and Its Responsibilities." Dr. Herty was in great form. He said that five years ago we chemists lamented the fact that we could not get a hearing. Newspapers paid no heed to our warnings or recommendations. Today the chemist has come into his own. Then he told what the Society had done to bring this about, of the development and work of its publicity bureau, commended certain books on popular chemistry that made one of the editors of CHEMICAL & METALLURGICAL ENGINEERING blush, and declared that clippings from newspapers today in regard to chemical news are generally correct and readable.

He referred to five public measures that affect the chemist in his work, some of which are still pending. These were respectively the Longworth, Bacharach, Nolan and Army reorganization bills and prohibition. At the mention of the last measure it seemed as though sympathy with the speaker was beginning to wane, but the only point that he brought out was the improvement of present over former regulations in regard to the choice of denaturants for alcohol. In regard to the Longworth bill, he said he never saw greater consternation than that depicted on the countenances of two leaders in the dye industry in Germany when they read in the Frankfurter *Zeitung* that it had passed the Senate.

The Nolan bill for increasing the facilities and appropriations for the Patent Office passed the Congress with but one dissenting vote. That would have been impossible a few years ago.

The Bacharach bill, which does away with duty-free apparatus for institutions of learning, is another feature of leading importance. If we train our young chemists to use foreign-made apparatus, glassware, porcelain, balances or the like, what chance will American-made apparatus have with them when they start out to work?

Everybody except the highest authorities in the War Department seemed to recognize the value of chemistry in warfare and fortunately, despite opposition, the Congress has seen fit to insist upon its continuation as a separate branch of the service. It is the obligation of



the chemists of America to give this department of the army our loyal and earnest support.

The National Exposition of Chemical Industries has been a great help in putting chemistry upon the map. And the authorized capital of chemical corporations within the past five years is nearly five hundred million dollars, while during the first three months of the current year new companies with capital of over sixty million dollars have been authorized.

Grave Responsibilities of Chemists

In view of these developments, chemists have grave responsibilities. They must be fearless and original. And they must provide for education. This is not a rosy side today. It is too much to ask men to remain as professors unless they can live on their salaries while industry offers so much richer rewards.

And again, if two such institutions as Cornell University and the Massachusetts Institute of Technology offer all the facilities of their staffs and laboratories to the War Department, and the Department, with a war before it, declares it has no need of chemical enlightenment or aid—which happened three years ago—there is something wrong. The error was corrected after expensive delay, but the question arises whether we are not to blame if such misconceptions of chemistry exist in high places. Since the armistice it has been proposed by the War Department itself that we build a $20,000,000 institution and provide for the complete chemistry of warfare by sending West Point graduates there who have had fourteen weeks in chemistry and giving them another year at it! Something wrong there, too. The fact is, Dr. Herty said, we haven't yet taught our people what chemistry means and we must do it. He quoted Prof. Duisberg of the Bayer Co., who said: "They will make a hard treaty for us, and we must accept. You beat us in production in this war, but we will beat you in production in the next war." And he brought out a record of German military plans to send over a dirigible airship 775 ft. long to drop five tons of poison gas on New York on Thanksgiving in 1918.

It was, in fact, a very lively speech.

Council Meeting

The meeting of the Council began at 4 p.m. at the University Club, but in response to the request of about thirty members who were delayed by the railway strike, all transactions were made subject to revision after their arrival at the evening session, which convened at 9:15. Members of the Council who were present were guests of the St. Louis Section at dinner during recess, at which about 100 councilors in all were present. It was resolved to hold the 1921 spring meeting at Rochester and the 1920 fall meeting during the second week in September at Chicago. There exists a tentative understanding between the American Chemical Society and the American Association for the Advancement of Science to hold the fall or winter meeting if possible jointly during convocation week once in four years if this should be possible, but the Chicago Section advised against it on the ground that it would be very difficult to secure proper hotel accommodations for members of both of these great bodies at the same time. It was recommended that the local sections in the neighborhood of Chicago join in a special meeting with Section C of the Association during convocation week (between Christmas and New Years) if such arrangement can be made. The request of the Pittsburgh Section to hold the fall meeting of 1921 in that city was held for consideration.

New sections were established at Denver, Col.; College Point, N. J.; Omaha, Neb., and Savannah, Ga. Mr. A. V. H. Mory of Cincinnati was elected councilor at large to fill the vacancy caused by the election of Dr. W. A. Noyes to the presidency.

It was also voted that nomination blanks sent by the secretary to local sections for nominations for the presidency shall include also blanks for nominations of councilors at large. Also that the Society unite with other associations in the formation of a standard metric system council. Drs. Alsberg, Bancroft and Derrick were re-elected representatives of the Society as members of the National Research Council. A committee of three was appointed to look into the question of preventing platinum thefts. Co-operation with the American Ceramic Society was determined upon. The heads of the divisions of abstracts were requested to co-operate with the British committee in preparing annual reports of the progress of chemistry in their respective branches.

A committee was appointed to look into and propose measures to remedy the present bad condition in institutions of higher learning in regard to the scarcity of instructors of chemistry and the inadequate salaries offered to them.

The question as to whether abstracts of all papers

presented shall be required to be sent to the secretary within a reasonable time before each meeting as a requirement to their inclusion in the program was tabled and a motion to hold meetings annually instead of semi-annually was made a leading subject for discussion and decision at the next meeting of the Council in September.

PASSAGE OF LONGWORTH BILL URGED

The following motion presented by Dr. HERTY was unanimously carried:

> The American Chemical Society, through its representative Council, urges upon our Senators the necessity of prompt passage of the Longworth bill in the form reported by the Senate Finance Committee. Under the absolute protection afforded by the blockade of German ports and encouraged by the favorable legislation of the preceding Congress, the coal-tar chemical industry has grown by leaps and bounds. But to meet the unusual competition threatened from the present unified German industry, far greater safeguards must be established than were formerly considered necessary. The delay in enacting such legislation has caused the withholding of large amounts of capital and the creation of an atmosphere demoralizing to research and to the technical development of the industry. We feel that the fate of this industry lies now with the United States Senate, and we urge the enactment of the bill as originally reported to the Senate by its Finance Committee, convinced that this legislative support will speed the industry's complete development, thereby assuring American consuming interests freedom from outside domination and providing a powerful factor in national defense.

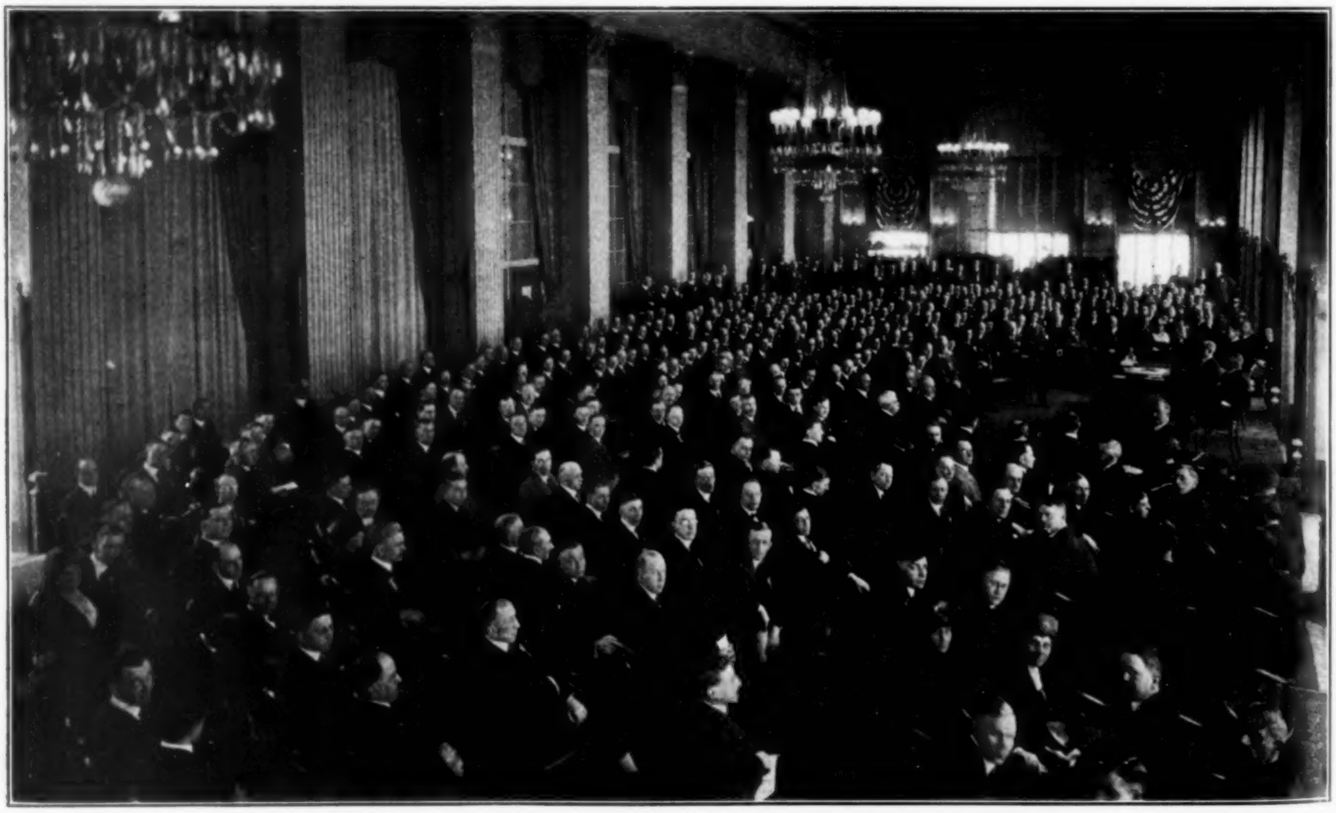
The Smoker

The smoker was held in the great hall of the Liederkranz Club on Tuesday evening. There were about a thousand persons present and the St. Louis Section provided an elaborate musical and dramatic entertainment, an excellent collation and a frothy, sparkling beverage from the great brewery at St. Louis that looked and tasted like beer, but wasn't. As some one said: "It was beer all the way down to the necktie; after that it wasn't." Some good topical songs were provided of which we might quote some verses, but won't!

The Banquet

The banquet was held at Hotel Statler and was largely attended by prominent citizens of St. Louis as well as by members of the Society. A. C. BOYLSTON, plant manager of the Mallinckrodt Works, presided as toastmaster. FRANK CARTER, of the St. Louis bar and president of the Chamber of Commerce, spoke of the growth of chemical industry and emphasized the importance of its position in relation to the development of agriculture as well as other activities in national well-being. Dr. FREDERIC A. HALL, chancellor of Washington University, urged a closer union between neighboring chemical establishments and the research facilities offered by the university over which he presides. He concluded with an appeal to chemists to bear in mind the great responsibilities which are theirs and cautioned them lest they neglect the spiritual aspect of life, which is the business of every man.

Dr. WILLIAM A. NOYES, president of the Society, followed with an outline of the growth of chemistry in America and emphasized the obligations of chemists to the general welfare. Dr. L. V. REDMAN, of Chicago, spoke for his section and offered felicitations to that of St. Louis. Dr. CHARLES L. REESE, chief of the department of research of the du Pont company, made a strong plea for the humanities as a preliminary requirement for the study of chemistry. He also urged better support of the teachers of chemistry on the ground that if we do not see to it that their opportunities and living conditions are improved, chemistry will cease to perform its function in this country. He declared that industry can neither prosper nor even hold its own unless teaching is made attractive to the best type of men.



AMERICAN CHEMICAL SOCIETY IN GENERAL SESSION IN ST. LOUIS

Dr. RALPH H. MCKEE, professor of chemistry at Columbia University, announced that he was born in Missouri and related some illuminating experiences. ELLWOOD HENDRICK, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, after a humorous introduction, replied to the appeal of Chancellor Hall with the suggestion that a broader and more general understanding of chemistry might aid in the development of spiritual life. He pointed out that the popular concept of astronomic magnitudes and of geologic ages had magnified the idea of deity until it ceased to be within the range of human understanding, and that this has destroyed the feeling of nearness and familiarity. It crippled the sense of things unseen by brushing their presence away from the earth. Chemistry, on the other hand, has to do with particles, powers and forces, amazingly minute. The study of it teaches us that the road to infinity leads in both directions; and with this in mind we might better attune our ears to the Still Small Voice amid the Silences. Dr. CHARLES C. CASPARI, chairman of the St. Louis Section, told of his experiences in planning for the meeting and made his acknowledgments to his associates in the work.

A subject that was not mentioned at the banquet but which may as well be recorded here is the debt of the New York members of the Society to HERBERT G. SIDEBOTTOM, of The Barrett Co., secretary of the local section, who provided railway accommodations and generally looked after their comfort and convenience with rare kindness, diligence and efficiency.

Physical and Inorganic Chemistry

PREDICTION OF SOLUBILITY

J. H. HILDEBRAND gave the present status of his work on solubility with corrections on his solute-solvent tables. The great importance of the problem of solubility has been recognized ever since the days when the first alchemists sought a universal solvent. It is true that we have become somewhat less ambitious, or perhaps somewhat wiser, because we realize not only the unlikelihood of success in such a quest, but also the difficulty, which seems not to have occurred to the alchemists, of finding a container in which one could keep a universal solvent. But the chemist still works largely with solutions. His methods of analysis depend almost wholly upon precipitation and resolution and his education consists, to a very large extent, in learning solubilities of substances.

Although this is true, it is also unfortunately true that there are few properties more difficult to predict than solubility. How many chemists are there who would dare to predict which of two newly discovered salts would be more soluble in water or whether the "mustard gas," used during the war, would be miscible in all proportions with gasoline or whether phosphorus would be more soluble in benzine or in chloroform?

Dr. Hildebrand felt many years ago that the scant progress made in the theory of solutions has been due largely to the fact that aqueous solutions, because of their great practical interest, have occupied the attention of chemists to the exclusion of nearly all others, and aqueous solutions are probably the most complicated of all because of the prevalance of dissociation and hydration and because water itself contains several species of molecules. Since it is always important in the development of a theory to proceed from the simplest cases, attention has been focused by the writer principally upon non-aqueous solutions. It is possible to report an amount of progress in this direction sufficient to justify a feeling of confidence that the foundation has been laid for a satisfactory treatment of the theory of solubility.

Most of the investigators of physical chemistry seem to think that osmotic pressure offers the only valid foundation for deriving the various laws having to do with solutions. The writer has chosen rather to proceed from a purely statistical law discovered by Raoult. This law states that, in a liquid mixture of two kinds of molecules, each molecule will have the same tendency to escape into the solid or vapor state that it would have if the liquid were composed entirely of molecules of its own kind. In mixtures obeying this law it is possible to calculate the solubility of either substance in the mixture, whether it be in the gaseous or solid form. We may say qualitatively that the higher the boiling point or critical temperature of a gas the less soluble it will be in any solvent; also that the higher the melting or subliming point of a solid the less soluble it will be in any solvent. Both of these statements follow from the idea that the process of solution consists in liquefaction and the farther the substance is removed from the liquid state the more difficult it is to liquefy it.

Now although physical chemists have been familiar with these principles for a long time, it has not been possible to state in advance what molecules would be sufficiently alike to behave in the ideal manner postulated by Raoult's law. We find that molecules may be very different in chemical composition and still be sufficiently alike to obey Raoult's law. It has, therefore, been necessary to search for properties which would furnish a true measure of the degree of similarity of different kinds of molecules so far as concerns attractive forces between them. This search has been successful and we are able to announce that by the aid of readily accessible data such as densities, boiling points, heats of vaporization, surface tensions, it has been possible to arrange substances according to their "internal pressures" in a table in which the near neighbors are sufficiently alike to obey Raoult's law very closely and hence to show solubilities agreeing with the calculations of solubility made on the basis of Raoult's law. On the other hand, the farther apart in the table the substances considered, the more unlike are their molecules in the sense of the attractive forces existing between them, and the less soluble they are in each other. Thus a substance at the bottom of the table would be less and less soluble as we proceed to solvents higher up. Almost without exception, the solubility data available agree with this generalization, and a number of predictions were made that have since been abundantly verified.

CHEMICALLY ACTIVE NITROGEN AND HYDROGEN

GERALD L. WENDT and A. C. GRUBB reported their success in obtaining chemically active nitrogen in the research laboratory of the University of Chicago. This form is produced by the corona discharge at 20,000 volts from a fine wire through pure nitrogen at atmospheric pressure. Under most favorable circumstances as much as 4 per cent of the nitrogen is transformed into an active form which reacts readily with hydrogen to form ammonia; with oxygen to form oxides; and with lithium, sodium, potassium, magnesium, aluminum, iron and zinc to form nitrides; and

with sulphur to form a sulphide. It is probably different from Strutt's nitrogen, which has been produced at low pressures, in that the latter gave neither ammonia nor oxides of nitrogen. Whether it is atomic or an ozone form has not been determined, but on account of its extreme stability the latter is more probable. It forms very slowly in the discharge and persists for hours afterwards, unlike the ozone forms of oxygen and hydrogen. It has a distinct odor resembling formaldehyde.

From a similar investigation on hydrogen, the authors report that the "ozone form of hydrogen" has now been prepared by the three methods—the action of alpha rays, in the vacuum electrical discharge, and in the corona at atmospheric pressure. Attempts to produce activation by means of Schumann light failed. The ozone hydrogen, or hyzone, is extremely unstable, reverting to the usual inactive form in less than a minute. Figures are given in a detailed study of the formation of ammonia from the hyzone and nitrogen, activated nitrogen and ordinary hydrogen, active nitrogen and hyzone, and mixtures of the two plain gases activated together and reacting in the corona.

Radiation and Chemical Reactivity

Eric K. Rideal described the application of the quantum theory. He stated that the kinetic energy of the molecule must not be neglected nor the relationships evolved by Plank misapplied as by some investigators in the past.

It is now generally recognized that the forces holding the atoms together are electrical in nature and that the angular momentum (Bohr) or the electromagnetic atomic flux (Bernouilli) of the valence electrons are universal constants. By the application of Plank's radiation hypothesis, it is evident that the energy changes associated with changes of state as in the latent heats of transformation or the electrolytic potentials of the elements as well as the heats of combination of elements and compounds, which all necessitate the movement of one or more valence electrons from their original to new orbits, should all be capable of calculations in terms of the various vibration frequencies of the electrons involved and the constant h of Plank's quantum formula.

The latent heat of evaporation of the elements can be calculated from the relationship $L = Nh$. Honda has calculated the latent heat of fusion and Langmuir the approximate values of the electrode potentials from the natural vibration frequencies of the atoms and the electrons, while the heats of formation of a great number of compounds have been calculated in like manner by Haber, McLewis, Bernouilli, Perrin and others.

The problem of reactivity is, however, somewhat different from the relationships discussed above and may be advanced in the form of a question. Will an atom or molecule become reactive when and only when we impart to its valence electron a quantum of energy, the critical energy increment?

Few experiments have been made to test this point. The vaporization of metal electrons (the photo-electric effect), the resonance of the vapors of sodium, iodine, mercury under suitable monochromatic radiation, the photochemical reactions, all indicate, however, the plausibility of the hypothesis.

On the other hand with the assumption of a purely kinetic critical energy increment, the Maxwellian distribution law offers a satisfactory solution to the problems of the rate of physical and chemical action, e.g., the rate of vaporization, the rate of thermionic emission or the rate of chemical reaction. According to Rice both factors are normally operative, but the kinetic contribution is small.

Attempts to accelerate the hydrolysis rate of an ester by infra-red radiation have so far yielded negative results, but calculation indicates that but a small effect is to be anticipated. Attempts have likewise been made to test the radiation hypothesis of reactivity by a study of catalytic action both homogeneous and heterogeneous. It may be assumed either that the catalyst increases the activating absorbable radiation density, suggested by the close relationship between reaction velocity and the specific inductive capacity of the medium, or, as is more probable, that it functions through the formation of an intermediate compound. This presupposes that a molecular species can exist in several possible stages of activation and differs from Baly's force field and C. N. Lewis's polar theory in that these possible stages of activation are associated with energy contents which vary *per saltum* and not continuously, corresponding to spectral lines in a Bohr atom. Thus it appears that oxygen requires activation to different extents for it to combine with activated hydrogen to form water, silicon to form silica, and ozone can possibly be formed in two distinct ways. A catalyst on this view would be easily activated itself and would react with the reactant after it has been activated by radiation which is plentiful in the medium.

It allows the reaction to proceed in the spectral region, which is more intense than that in which the reaction normally takes place; it does not alter the radiation density to suit the reaction but the reaction to suit the radiation density.

In heterogeneous catalysis we may likewise assume either an increase in the absorbable radiation density in the film in contact with the catalyst or, as is more likely, we may postulate the formation of intermediate adsorption compounds of the types suggested by Langmuir, the reactants and catalyst being activated in the usual way. In heterogeneous catalysts we have therefore two factors operative: first, those influencing surface adsorption, such as superficial area, poisons, product adsorption, excess adsorption of one reactant, slow diffusion, and, secondly, activation governed by the rates of supply of radiation of particular frequency. Thus palladium may be regarded as a better hydrogenating catalyst than iron, not because its hypothetical hydride is more labile, or because the density of the radiation which activates hydrogen is denser at the surface of the palladium than iron, but because palladium will react with hydrogen which has been slightly activated, while iron will react only after the hydrogen has received a much larger critical increment.

Hydrated Hydrogen Ions

James Kendall, of Columbia, indicated the trend of his investigation on the ionization of strong electrolytes, especially acids having both free hydrogen and hydrated hydrogen ions. His work is expected to clear up certain points on the irregularity of ion velocity under electric potential as well as give data of value in the study of solubilities and solutions.

Radium-Uranium Ratio

S. C. Lind and L. D. Roberts gave the results of their investigation on the radium-uranium ratio, which

they found to be 3.398×10^{-7}. This is in close agreement with the 1908 value.

Nitrogen Chloride

W. A. Noyes and George H. Coleman reported progress in their work on the formation of nitrogen trichloride. They have obtained a yield of a few milligrams by the use of the traveling arc in a mixture of the two gases.

Ozone and Nitrogen Oxides

F. O. Anderegg spoke on the present progress of his investigations at Purdue University on the formation of ozone and nitrogen oxides from air in the high frequency corona. He pointed out that the lack of important accomplishments in the past was due to the fact that the underlying principles were not worked out and designs were being made from too limited an amount of empirical work. He predicted that much higher yields of ozone will be obtained with low concentrations of the undesirable nitrogen oxides in the near future.

Selenium Oxychloride

Victor Lenher presented a paper on selenium oxychloride, a neglected inorganic solvent. He called attention to the fact that selenium is not a rare element, but is commonly secured from the anode mud in copper refining, by fusing with sodium nitrate and sand. This forms a selenite and tellurite which is further treated with sulphuric acid.

Selenium oxychloride is a liquid whose properties have hitherto been almost wholly neglected. The raw material, selenium, is at present a waste byproduct from the electrolytic refining of copper. From the crude material selenium oxychloride can be produced at a very low figure and by the most simple chemical procedure, the actual procedure being to bring in contact selenium dioxide and selenium tetrachloride in carbon tetrachloride solution.

Its chemical properties are such that it will likely prove a valuable reagent to the chemist. It is an excellent solvent for many of the inorganic oxides which are commonly considered to be very refractory in character. Molybdenum trioxide, for example, can readily be separated from the oxide of tungsten. The solution of molybdenum trioxide in selenium oxychloride shows a deep indigo blue color when exposed to bright light, the solution again becoming colorless when placed in the dark.

The reagent is an excellent solvent for unsaturated organic substances. The unsaturated hydrocarbons and aromatic hydrocarbons dissolve readily in the solvent, while the paraffine hydrocarbons do not. Bakelite, redmanol, the waterproof insoluble casein glue used in airplane construction, pure rubber, vulcanized rubber, asphalt and bitumen dissolve with ease. The bituminous material can be dissolved from soft coal, leaving a carbonaceous residue.

The vegetable oils mix readily with the reagent, while with raw linseed oil a rubber-like mass is formed, quite similar to that produced by the action of chloride of sulphur on certain oils.

The chemical behavior of the reagent is quite selective. Many inorganic oxides are completely insoluble in it, while others dissolve with ease, making possible many separations. Metallic sodium is not acted on by the reagent, even at 175 deg. C., while with metallic potassium a violent explosion takes place.

Study of Plant Distribution and Plant Life

D. P. Wherry, in a study of plant distribution with hydrogen ion indicators, has found that it is a matter of common observation that certain geological formations or certain types of soil are prolific with certain types of plant life. Whether the limitation is due to chemical or physical factors is in dispute, although most writers favor the physical theory, considering the texture of soil, amount of water available for the plants, climate, etc., as all-important. It is noteworthy, however, that few chemical studies have been made by these writers.

The only sound method of treating the subject is on the basis of the ionization theory, and this will be accepted eventually. Thousands of tests with many of the native soils show that plants require a definite hydrogen ion concentration. Plants belonging to the orchid family are particularly sensitive in this respect.

The speaker urged that modern physical-chemical methods be applied in the study; that instead of the p_H method, one be substituted with calculations beginning at the neutral point, and that in addition to the study of native plants, attention be paid to the soil acidity capable of giving the best yield with all of our ordinary crop plants.

Chemical Resources of the St. Louis District

O. H. Pierce, in speaking of the chemical resources of the St. Louis district, defined the position of the chemist as one who changes the raw materials into articles for the use of the people. He pointed out the importance of the two classes of raw materials, namely, the mineral and agricultural products of a district. Of these, by far the more important to the chemist are the mineral resources. J. E. Spurr, editor of *Engineering and Mining Journal*, was quoted as saying that literally and figuratively the people who control the mineral resources own the earth.

The district which was covered included all of Missouri, southern Illinois, western Kentucky and Tennessee, northern Arkansas, eastern Oklahoma and eastern Kansas. A comparison of the resources of the district with those which are considered of high importance to the chemical industries showed that the St. Louis district was very nearly self-supporting. In coal, petroleum, lead and zinc it takes a very leading part; in aluminum ore it is practically the sole contributor. This is also true of various other products of minor importance.

The agricultural products of the district are of three general types: The live stock, which contributes to the leather industry, to edible oils and fats and to glue—the live stock being of chief value; the corn-belt area, which lies to the north, contributing largely to the corn products industries; the district overlapping the cotton-producing areas, to the south, which contributes largely to the prominence of St. Louis in the cottonseed oil and cottonseed cake industries.

Chemical Warfare

Colonel Amos A. Fries, the new director of the Chemical Warfare Service and recently Brigadier General in command of the Chemical Warfare Service in France, delivered an illustrated public lecture on Wed-

nesday evening, April 14. He revealed a condition not even suspected by the general public, and that is that large quantities of poison gas made in the United States are still in storage and show no signs of deterioration. The Government did not know that this gas would be of much value, and had begun to sell quantities of it for industrial purposes. The demand of various manufacturers for these death-dealing gases has been so great that several of them will not be sold for the present for fear of cutting down these reserves.

Phosgene, one of the deadly gases in use early in the war, is now extensively used in the making of several shades of green dyes. It is also employed as a deodorizer, and on account of its effect on oxide of iron it is very valuable for bleaching sand in the making of optical glass. Out of the war gas phosgene has been evolved a means of breaking the German optical glass monopoly. The special value of phosgene as a bleaching agent was first appreciated at the Edgewood Arsenal, where it was seen that the gas had bleached the brickwork almost white.

Considerable quantities of chlorine, made originally to be compounded with other gases for military use, have been disposed of by the Government for industrial purposes, much of it being used in chlorinating the water supplies of cities. Although as yet no industrial use has been found for mustard gas, it is thought that the research along the lines of determining its uses is justified. Considerable quantities are still available.

If the deadly vapors which slay in war can also be made to serve many industrial uses, the Chemical Warfare Service would be made all the more effective.

The Government cannot afford to attempt an organization even one-tenth the size of that which brought the assistance of 1,200 technical men and 700 service assistants, and the co-operation of universities and industries during the war, now that the Chemical Warfare Service is operating on a peace basis. The Chemical Warfare Service must maintain a small research organization. There will be certain lines of investigation that can best be carried out, which no other institution desires to touch. It must have enough trained men to tell at least tentatively whether a new idea, a new substance or a new method can be successfully adapted to chemical warfare. This will involve in large measure a thorough understanding of military problems, military organization and military methods.

The thousand research men who are working throughout the United States to every one that the Chemical Warfare Service can maintain will certainly bring forth 75 to 90 per cent of all new ideas, materials and methods for use in chemical warfare. It is hoped that such knowledge and such touch with the various chemical industries may be kept and that we can count on this one and that one to produce within a given number of days, on the outbreak of war, a given quantity of gases. The Edgewood plant should be capable for at least five years, with moderate upkeep, of being put into large-scale production on short notice.

Industrial Chemistry Division

Effect of Impurities on the Metallurgy of Tungsten

Clarence W. Balke, in speaking of the effect of impurities on the metallurgy of tungsten, divided the impurities into two groups, the first being those metals which were reduced in tungsten powder in the hydrogen furnace. These included gold, platinum, iron, calcium, nickel, etc. The second group consisted of the oxides which are not reduced, such as arsenic, sodium, caesium, magnesium, lanthanum and thorium. He found that iron cobalt and nickel produced exaggerated growths when carried over into the sintering furnace, causing the bars to crack when placed in the swaging machine. Sodium and other metals cause a shrinkage of 0.04 per cent and retard the formation of the proper grain structure in the first group. Conclusions from his investigation have shown that any impurity in the process is detrimental to the proper working of tungsten metal.

Carbonization of Missouri Cannel Coals

An investigation on the carbonization of Missouri cannel coals by H. L. Dunlap and K. K. Kershner was described in detail. Five different cannel coals were subjected to destructive distillation in a gas-fired horizontal retort and the results compared with a bituminous coal coked under the same conditions. Both the oils and gases collected at different stages of the carbonization were examined.

The oils from cannel coals have a low specific gravity and consist chiefly of paraffine hydrocarbons. These oils resemble the oils obtained by low-temperature carbonization of bituminous coals. Cannel coals yield a larger quantity of gas than bituminous and this gas has a high calorific and illuminating value. Only two of the coals examined gave a coke of any commercial value. Cannel coal might be of value to mix with bituminous coals for gas production because of the high illuminating value.

Specifications for Chemical Reagents

W. D. Collins opened up an interesting discussion on problems and specifications for reagent chemicals. The chemist does not specify definite properties for the chemicals he purchases on the market. Some progress has been made on getting up a set of specifications for the chemist similar to that issued in the U. S. Pharmacopœia. The following suggestions were offered for discussion:

The American Chemical Society should establish and publish specifications consistent with good manufacturing practice. Methods of determining strength should be fully prescribed. Only impurities likely to be present should be considered. A blank test should be prescribed and the specifications should obtain no provisions for penalties, but should be left to individual dealings.

Extracting Furfural From Corncobs

H. L. Dunlap and K. K. Fischlowitz presented the results of experiments on extracting furfural from corncobs. Although furfural has hitherto been known as a comparatively rare organic chemical, a number of uses for it are already known, and the field for future developments seems very promising. The series of dyes may be produced by inter-action with various coal-tar derivatives; hard resins similar to the well-known bakelite; and also soluble resins which may find application in the varnish and lacquer trade. Furfural, although not as efficient as formaldehyde, has antiseptic and deodorizing qualities and has also found use as an insecticide. It is a yellow aromatic oil of high boiling point, 162 deg. C., and has an odor closely resembling

benzaldehyde. It may be extracted by treating sulphuric solution of corncob pulp with live steam in an Elyria enameled kettle and subsequent extraction with benzine. Theoretically about 10 to 11 per cent by weight of furfural may be extracted from the corncob pulp, but results so far obtained give a commercial extraction of 4½ per cent.

Standardization of Laboratory Apparatus and Instruments

THOMAS B. FREAS, in speaking on the standardization of laboratory apparatus and instruments in respect to quality, shape, size and packing, showed the need of the manufacturer for having standard sizes of laboratory apparatus so that he might produce on a quantity basis. He showed how in Columbia University 50 per cent increase in laboratory efficiency was accomplished by standardizing the apparatus used. He further proposed that a standard office be organized and supported by the American Chemical Society.

Crystal Growth in Bearing Metals

EDWARD J. MAHIN, of Purdue University, spoke on the crystal growth in bearing metals and inclusions and ferrite crystallization in steel, together with the solubility of inclusions. Bearing metals are essentially a conglomerate of hard crystals in a soft matrix. Heat treatment does not change the structure where inclusions are encountered. Numerous metallographic slides were presented showing the migration of phosphides when metal plugs of the non-ferrous metals as well as the ferrous metals are inserted in holes drilled in a steel plate and subjected to heat treatment. The introduction of a third element has some effect on the solubility of ferrite in austenite.

Apparatus for Recovering Iodine From Kelp

MERLE RANDALL described an installation of apparatus which is being put into operation at the Government kelp plant on the Pacific Coast for the recovery of iodine from kelp leach liquors. Iodine and decolorizing carbon will be produced.

Selenium and Tellurium

VICTOR LENHER, in a paper on "Selenium and Tellurium," showed that the supply of these elements was not so rare, as over 300,000 lb. of selenium and 125,000 lb. of tellurium are produced annually. The complete results of his experiments with these two metals will be produced in a later issue of CHEMICAL & METALLURGICAL ENGINEERING.

Incentive to Research

WILLIAM J. HALE of the Dow Chemical Co. described a plan by which industrial concerns could offer more incentive for research in pure and applied chemistry among the graduate school men in the American universities at large and especially among the younger members of the faculties. He stated that he was convinced that large donations are available for the asking, which could be used in rewarding those men financially whose published papers were judged to be worthy of national recognition. Titles such as assistant director of research should be given by the universities to those men who have received such rewards repeatedly and thus proved their ability. Dr. Hale thought that from $500 to $1,000 should constitute the ordinary reward, which, added to the salary of an instructor, would tend to make it more sufficient, as well as make him more efficient.

Economic Status of the Chemist

A. M. COMEY of the du Pont company reported the findings of the investigation on the salaries paid to chemists based on the number of years since they completed their college training. He showed that, on a total average, salaries were rapidly advanced and were not as low as has been currently believed. A motion was made to recommend to the Council that a canvass be made by sending a questionnaire to all the members of the society to determine both salaries and grades of chemical work being done.

Specific Heat of Petroleum at Different Temperatures

F. W. BUSHONG presented a lecture with curves showing the "Specific Heat of Petroleum at Different Temperatures," and concluded that specific heat is proportional to or a function of the absolute temperature, including the paraffines. Curves compared the work of Nernst, the Bureau of Mines, Schiff and Mayberry with the work done in the research laboratory at Kansas University.

Filter Presses

D. R. SPERRY presented an instructive and interesting paper on the application of the filter press to problems in chemical industry. The filter press is a press only in that plates are held together by the action of a hand screw and is not used to squeeze the solution from the slurry. It is used to separate solids from liquids and to lixiviate the residue by a washing process. Simple washing occurs subsequent to the filtering operation, in which case the recesses containing the cakes are not completely filled before the washing. Thorough washing is in operation where the wash water is introduced behind the filter cloth.

Chemical Corrosion

D. P. SHAW gave a new method for determining chemical corrosion. The loss of weight is not taken into consideration, but rather the equivalent depth of penetration of the corroding agents in the metal over unit periods of a month's time. Corrosion depends upon the shape of the piece, the volume of the solution, the temperature, the time of exposure and the methods of cleaning test pieces. Of these the concentration and temperature are the most important features and time also has an appreciable effect in the fact that an exposure under twenty-four hours does not give reliable results. Tests should be carried on for at least forty-eight to ninety-six hours. He concluded that this was a very important subject on which little work had been done and that the three most important factors are fusion coefficient, velocity of corroding solution and the ionization coefficient.

A New Type of Catalyzer

W. D. RICHARDSON presented a paper on a new type of catalyzer for the hydrogenation of oils and other purposes. This paper is published in full on page 793 of this issue.

Specific Heat of Heavy Mineral Oils

HERBERT BAILEY and C. B. EDWARDS presented the results of investigation on the determination of the specific heat of heavy mineral oils and described the practical application of oil for transmitting heat in chemical plants. The apparatus used was a thermos bottle equipped with a stirring arrangement and into which a nichrome coil was introduced with leads attached to a pyrometer on the outside. The results were plotted with specific heat against temperature ranges.

Potash and Reconstruction

J. W. TURRENTINE spoke on "Potash and Reconstruction." Upon the signing of the armistice most of the potash plants in America put out their fires, because it was thought that immediately Germany would flood the American market with all that potash which she had not exported during the period of the embargo and which in the imagination of the American producer was being piled up in Germany. Unfortunately for the American producer, this was a false alarm. Germany during the war period was not engaged in the production of anything that she didn't have immediate need for.

Now in Europe the potash monopoly, formerly entirely in the hands of Germany, is divided between the Germans and the French, the French having acquired very important and valuable potash mines which were situated in Alsace. The world hoped from this division to obtain potash under competitive conditions and at reduced cost, but one hears more of mutual understanding between these two interests to establish prices than prices being reduced through competition.

However, there is one very important difference between the present situation and that which existed before the war, and that is that where before the war the Germans sold potash to the American farmer at 60c. per unit weight delivered in New York, he is now charging his own farmer $2 a unit weight, delivered at German points. It is hard to see what chance, therefore, the American farmer has of getting potash cheaper than the German farmer. Therefore, the American finds himself between two difficulties, an exorbitant price for foreign potash and an American potash industry largely shot to pieces through lack of informed and concerted opinion.

The Summerland, Cal., Kelp Experimental Plant

He further described in a subsequent paper the experimental plant at Summerland, Cal., which was founded for the purpose of ascertaining if any American potash industry could be based on the giant seaweed as the raw material. To date about thirty products, byproducts and derivatives have been established as obtainable from kelp when processed in the manner in vogue there. Some of these have commercial value and some have little or none. Among the products are such materials as potash and various salts of potash, table salt, crystalline iodine and various salts of iodine, ammonia in various forms, bleaching carbons of various grades, oils of different characteristics and degrees of usefulness, creosote and disinfectants and other derivatives prepared from it, pitch, prussian blue, and combustible gas; and of these potash salts, iodine, bleaching carbons, ammonia, oils and combustible gas are obtainable profitably. However, to date only potash, iodine and bleaching carbons have been put on a commercial basis and soon are to be produced on a large scale as a part of the daily operation of the plant.

Thus, three products, potash, iodine and bleaching carbon, for which America has been dependent on foreign countries, are now being produced from kelp. This dependence will be entirely wiped out with respect to iodine and bleaching carbon, and certainly at least impaired with respect to potash.

A considerable number of papers were read by title only and will appear later in the publications of the American Chemical Society.

Sugar Division

S. J. OSBORN of the Great Western Sugar Co. opened the first meeting of the sugar section by showing how vital chemical control was to the beet sugar industry. He claimed that, as a matter of fact, the sugar industry leads all others in chemical control. All the operations, from those of the beet grower on down through the extraction plant and refinery, are watched for even the smallest fractions in variations of sugar percentages.

Testing and Using Saccharimeters

C. A. BROWNE spoke at length on testing and using saccharimeters. He announced that the first instrument to be made in America had recently been turned out at Rochester and it was hoped that during the coming year one hundred instruments would be manufactured.

Refining Sugar Juices Mechanically

F. W. ZERBAN gave an excellent account of some recent work in refining sugar juices by mechanical means. As is well known, such active chemicals as sulphur dioxide, lime, and acid phosphates contribute certain disadvantages as well as benefits in their use in sugar refining. Mr. Zerban used quite large amounts of Filter-Cel mixed with an imported Dutch bleaching carbon called noirit, which mechanically removed the juice impurities. The molasses obtained resembled a cane sirup and should sell at a high premium. The process was too new to derive figures as to its exact economic status, but there can be no doubt as to its feasibility.

Dye Section

CHARLES L. REESE, chairman of the Dye Section, in opening the proceedings of that section, said that the American dye industry gave great promise of success and its progress would be largely dependent upon favorable legislation.

The commercial aspect of the dye business is obviously of first importance; unless the industry is managed well, as a commercial enterprise, it cannot succeed even with the best technical staff and equipment. The past twelve months have not been characterized by the same rapid flow of capital to new ventures in chemical commerce, but that is a healthy rather than an unhealthy symptom, because there was a tendency to rashness evident in much of the promotion entered into just before and after the close of hostilities. The significant feature is that much has been done to put the industry on a sound basis and to safeguard the investment already made. There has been, however, considerable reluctance on the part of those in charge of the finances of the industry to make additional investments when the money was needed for the proper development of projects already under way, on account of the lack of accomplished legislation to protect this young key industry.

ENCOURAGING RESULTS OBTAINED IN THE DYE INDUSTRY

The dye industry is yet too young to have proved itself worthy of the confidence of those who have shown their belief in it by giving it financial support, but the recent developments have tended to show that the confidence was warranted. The technical development has been very apparent to those in close touch with the details of the industry. Yields have been pushed up with a resultant saving of material. The quality of intermediates and finished products has been very markedly improved and in addition it has been possible to increase the diversity of colors manufactured.

This is all very gratifying, but to me the most significant thing about it is not material, but rather mental—it is a measure of the rapid growth of knowledge among our technically trained men and shows, I take it, that they are entirely capable of developing that profound specialized knowledge of applied organic chemistry which is an essential of a successful dye industry.

IMPROVEMENTS IN THE EQUIPMENT OF THE DYE INDUSTRY

There is another pleasing feature of recent progress; designers of chemical equipment have shown that there is still much that can be done to improve the mechanics of the dye industry. They have not been content to reproduce foreign designs, they have struck out for themselves, and have already made some revolutionary improvements. This I consider very important because it shows that this industry is a fertile field for American ingenuity, and that we can expect to make very important economies in characteristically American ways.

NEED OF EDUCATING THE LABORERS FOR THE KIND OF WORK THEY HAVE TO PERFORM

Besides the technical man there is another worker in the plant upon whom a great deal depends; he is the wage earner. Even the simplest operations about a dye plant are important and may make or mar a product. The use of a metal instead of a wooden shovel, or similar careless handling in any little particular may mean ruin to valuable material. Until the laborer learns the meaning of this there will be unnecessary trouble. I think that some effort should be made to educate the right kind of men by giving them elementary courses in chemistry, or at least by seeking to give them some understanding of their duties, so that they may learn to do them in something more than a mechanical way.

The German employers gave great attention to provision of everything possible to make their labor permanent and content; free hospitals, reading rooms, swimming pools, special classes in cooking for the girls, kindergartens for the children, all these and many other advantages were provided. I think that this is a feature of the German industry which we shall find it necessary to adopt, though in a modified form, which will suit our special conditions.

PROGRESS OF INDUSTRY DEPENDENT ON LEGISLATION

Legislation of the utmost importance to the industry is under consideration. It is quite clear that the young industry must have protection—that is agreed to by nearly everyone—but the means of attaining the end has been the subject of much debate. It seems certain that adequate protection will be forthcoming and that a law will be enacted which will insure a far more satisfactory tariff than has ever before been in effect, one which has been formulated with the constant advice of experts.

In addition we may hope for an embargo for the next three years. It is a pity that action has been delayed so long. Even though the delay may have been justified, yet it has acted as a powerful deterrent to the erection of plants necessary for the proper expansion of the industry.

GERMAN DYE PATENTS

SAMUEL A. TUCKER dealt with the classification of the 671 German dye patents owned by the Chemical Foundation which forms the largest division of any class of enemy-owned United States patents taken over by it, and covers practically all classes of dyes. The method of classification followed enables one to locate any patent either by the chemical constitution of the dye or its application. Many of the 134 patents actually licensed either by the Chemical Foundation or the Federal Trade Commission were discussed at considerable length.

A list of patents of which the Schultz number was known but which had not yet been licensed was given. The advantages in the form of license as issued by the Chemical Foundation were pointed out and the influence which the company may have on the American chemical industry was discussed.

Leather Chemistry Section

The first meeting of the Leather Section of the American Chemical Society was opened by the chairman, Dr. LOUIS E. LEVI, with a graphic description of chemical work in the tannery. He described the difficulty with which the chemist entered the tannery twenty-five years ago as compared to the ease with which he now works in the chemical control of this industry at the present time. In these days of mineral tannage the chemist must control the tanning liquors as well as all chemicals which are bought by the purchasing agent. As the tanning of today is yet in its infancy, the research chemist has a load of precious tanning methods to uncover and operate for the great material benefit of his employer and himself.

THE TRUE TANNING VALUE OF VEGETABLE TANNING MATERIAL

JOHN ARTHUR WILSON and ERWIN J. KERN read a paper on "The True Tanning Value of Vegetable Tanning Material," and described a new method of analysis for determining the tannin content of these materails in contrast to the present methods of the American Leather Chemists Association, which was revolutionary in the extreme. The American Leather Chemists Association method varies from 43 per cent to 198 per cent in error as compared with the new method.

The new method requires more time, but gives greater accuracy and uniform results. The hide powder used in this method is not chromed. The moisture content of the hide powder has no effect, and the analysis may be easily and effectively accomplished.

The discussion on this paper brought out the fact that the actual yield of tannin in leather when analyzed closely checks the result of the analyses.

The chemical action of tanning was defined as the formation of chemical combinations by the reaction of the proteids in the hide with acid, salt, and even bases.

The Currying of Leather for Belting

Edward E. Marbaker delivered a paper on "The Currying of Leather for Belting." The tanning of steer hides produces the heavy leather from which belting is made. The leather, as it leaves the tannery, is not suitable for belting, because it is hard, harsh and more or less cracky. It must be thoroughly scoured to free it from dirt and excess tanning extracts and loading materials when such are present. The next step is to "set out" the butt, a process which flattens out the irregularities of the surface, such as wrinkles. Subsequently greases and oils are introduced into the leather, and the final product is pliable, smooth to the touch so far as the grain is concerned, and very much stronger than the original "rough" leather. It is in this form that it is used for belting, and the process of cleansing or greasing or "stuffing" is known as "currying."

Leather for belting is tanned in the form of butts, which are hides with the heads, bellies and flanks removed. The finished butt is from 70 to 80 in. long, from 48 to 54 in. wide, and weighs from 20 to 30 lb. This may be handled whole, but usually it is cut into a center and two side pieces, these varying in width according to the kind of belting for which the leather is to be used. The scouring process is then carried out on these three pieces separately. It is purely mechanical and is carried out on machines which give a very efficient scrubbing.

The scoured leather may or may not be dried out before "stuffing," according to the process which is used. There are three general methods of stuffing: (1) the cold hand process; (2) the hot hand process; (3) dipping.

Other Papers

Other papers presented in this section were as follows:

John Arthur Wilson and Edwin A. Gallun, "The Neutral Salt Effect and Its Bearing Upon Leather Manufacture."

Erwin J. Kern, "The Determination of Sulphate in Sulphonated Oils."

Arthur W. Thomas, "A New Method for the Determination of Sulphuric Acid in Leather."

Arthur W. Thomas and M. J. Kelly, "Time Factor in the Absorption of the Constituents of Chromic Sulphate Solutions by Hide Substance."

Arthur W. Thomas and S. B. Foster, "The Conductivity Titration of Chrome Liquors."

I. Newton Kugelmass, "Physico-Colloidal Interpretations of the Tanning and Tawing Procedures."

Colloid Symposium

Under the joint chairmanship of Profs. W. D. Harkins of Chicago University and Harry N. Holmes of Oberlin College, the most important technical event of the meeting was held in the great ballroom of the Hotel Statler on Thursday morning. The various divisions of the Society suspended their activities in order that all the members might attend this symposium. There was standing room only, and most of that was occupied.

The paper by Jerome Alexander on some practical aspects of colloid chemistry was read by the chairman.

What promises to be one of the most far-reaching advances made under the stress of the recent war, when necessity literally was the mother of invention, is the discovery that by means of a suitable fixation or peptizing agent and suitable treatment very large percentages of sheet tars and finely powdered coal may be dispersed in fuel oil with a sufficient degree of permanence to enable the mixture to be stored, piped, atomized and burned practically like fuel oil itself.

Since it will at one stroke relieve the drain on the earth's rapidly diminishing stores of petroleum, as well as lead to the efficient utilization of all kinds of coal waste, such as culm, screenings, and dust, inferior fuels, such as peat and lignite, and even cellulose waste, such as slabs and sawdust, this new composite fuel may be hailed as a powerful factor in the conservation of our natural resources and as a lasting benefit to mankind.

Realizing the vital importance of the Allied oil supply in the conduct of naval, military and manufacturing operations, the German submarine bent every effort to destroy tankers. Marshal Foch is said to have cabled America, "If you don't keep up your petroleum service we shall lose the war." While the Allied navies were dealing with this peril in a most decisive fashion Lindon W. Bates, of New York, head of the Engineering Committee of the Submarine Defense Association, with the assistance of Dr. F. E. Shepperd and other chemists of the Eastman Kodak Co., courteously opened to him, developed a colloidal fuel which, by practically doubling the usefulness of every oil cargo would, of itself, have materially assisted the defeat of the Hun's efforts.

Coal or other combustible solid is prepared for dispersion by being pulverized so that about 95 per cent passes through a sieve which has one hundred meshes to the inch. This means, of course, that by far the greatest weight is in particles hundreds and thousands of times larger than colloidal dimension.

Wilder D. Bancroft followed with an appeal for more light on the nature of gelatinous precipitates. He asked why ferric-hydroxide plus a certain amount of water gave a gelatinous precipitate. Is it ferric-oxide and water? This is probably the true condition of precipitate, because when water vapor comes off continuously from the compound it finally goes over to ferric-oxide upon standing. A distinction should be made between gelatinous and colloidal precipitates.

Colloid Chemistry of Soaps and Proteins

Martin H. Fischer presented an exhaustive paper on the "Colloid Chemistry of Soaps and Proteins," illustrated by charts and many samples of colloidal soap mixtures.

On the assumption that the polymerized amino-acids which we call proteins react with bases of various sorts to form salts in the same fashion in which fatty acids unite with bases of various sorts to form soaps, the colloid behavior of the former is accounted for.

The hydration capacity of the soaps varies with the basic radical, and, in general, in the order: NH_4, K, Na, Li, Mg, Ca, Fe, Cu, Hg. It varies also with the type of fatty acid, that standing lowest in any homologous series being least hydratable. When different series are compared, the less saturated possess the lower hydration capacity.

Colloid soap jellies may be prepared from the various soaps and anhydrous solvents, like monatomic, diatomic, and triatomic alcohols, aldehydes, benzene, toluene, etc. This finding speaks against the too heavy emphasis now being placed upon purely electrical notions of stabilization in colloid systems.

Hydrophilic or lyophilic colloids are defined as dispersions coarser than molecular, of one material in a second, with the dispersed substance a solvent for the dispersion medium.

Liquid soaps may be "coagulated" by alkalis and neutral salts of various kinds even when chemical reaction between soap and added substances is impossible. The consecutive changes of setting, secondary liquefaction with progressive dehydration of the soap, and its separation in "coagulated" form are explained on the basis of union between added salt and water with production of an emulsion of salt water in soap succeeded by one of soap in salt water and ending in anhydrous soap floating upon salt water.

Chemically neutral soaps do not affect an indicator like phenolphthalein in concentrated solution. On diluting with water they turn it bright red. This means either (1) that water-in-colloid system (analogous to normal cells and body fluids) cannot be properly analyzed by indicator methods but only colloid-in-water systems (analogous to the secretions from the body), or (2) that the former contain no ions.

From qualitative and quantitative analogy in colloid behavior between soaps and protoplasm the latter is held, in essence, to be a salt compound of various polymerized amino-acids with potassium, sodium, magnesium, calcium, etc., which materials have "dissolved" a certain amount of water. Introduction of acid, ammonia, or potassium into this compound represents poisoning by these materials at one end of such a soap-like series (as evidenced by increased hydration capacity and increased solubility in water); introduction of the heavy metals poisoning at the other end (as evidenced by a decreased hydration capacity and the production of difficultly soluble compounds). Just as a soap anywhere in the series can, by appropriate means, be converted into any other, just so can a normal protein or living cell be "poisoned" through the addition of materials found at either extreme in the base series; or after such poisoning be changed to nearer the normal by addition of the bases in the middle series.

Considerable discussion followed this paper in which G. H. A. CLOWES delivered a very instructive little homily on the "Chemistry of Living Substances," followed with a description by H. N. HOLMES and an exhibition of a 10 per cent dispersion of calcium stearate with machine oil and water to form a gel. If the mixture is allowed to set and cool it forms a gel, but if stirred while cooling a smooth grease is obtained. The stirring of the gel after it is cooled gives a mixture of curd and thin liquid which never attains the consistency of the grease as mentioned in the first instance. This is an example of a very intimate mixture in the case of forming grease, and in the second case, one of minor emulsion.

VEGETABLE TANNING AS A COLLOID-CHEMICAL PROCESS

A remarkable paper in more ways than one was that presented by JOHN ARTHUR WILSON on "Vegetable Tanning as a Colloid-Chemical Process." It is rare, indeed, that as valuable a contribution is made to an industry as this one in which the results of four years of intensive research were revealed. The paper is also a leading contribution to pure science.

Preliminary to vegetable tanning, a hide is freed from hair, epidermis, and adipose tissue, leaving only the corium, which consists chiefly of bundles of collagen fibers. The prepared hide is then hung in a very weak solution of the tanning material and moved to a stronger liquor each day or two until completely tanned. Vegetable tanning, then, is simply the reaction taking place between the substance collagen and the soluble matter extracted from certain vegetable materials and known as tannin. It is with the mechanism of this reaction that the paper deals.

Any continuous piece of collagen, such as a hide fiber, is believed to be made up, not of individual molecules, but of chains of atoms forming a three-dimension network with interstices, while too small to be detected with the microscope, yet very much larger than the simpler molecules and ions. A hide fiber may thus be looked upon as a single large molecule. This structure gives collagen an enormous surface per unit mass and is probably responsible for its colloidal properties.

In practice, all tan liquors are slightly acid and, when the hide is immersed, water and some of the soluble matter, including acid, diffuse into the interstices of the collagen network. But the collagen readily combines with the hydrogen ions of this acid, leaving the corresponding negative ions in the solution immediately in contact with the network. Now the presence in the absorbed solution of these negative ions balanced only by the electrical charge on the network causes an unequal distribution of all ions between the absorbed and unabsorbed solutions, and this in turn causes an electrical difference of potential to be set up between the two solutions, which can be varied at will, within limits, by the proper addition of acids or salts.

On the other hand, the tannin particles are negatively charged and balanced by an equivalent number of positive ions confined to the thin film of solution immediately in contact with the surface of the tannin particles. But the presence of these positive ions results in an unequal distribution of all ions, and therefore in an electrical difference of potential, between the surface film of solution and the main body of solution. However, this potential difference will be of sign opposite to that in the case of the collagen. Hence the surface film surrounding the tannin particles will tend to merge with the solution in contact with the collagen network; and when this occurs, the positively charged collagen and negatively charged tannin will neutralize each other by combination, forming leather.

The essential practical point to be brought out is that it is not the absolute values of the electrical charges alone that determine the rate and nature of the tannage, but the differences of potential referred to, which can be varied without altering the absolute values of the charges. The application of this theory is being pushed in the hope of improving the tanning process and placing it upon a more scientific basis.

CERAMIC PROCESSES ASSOCIATED WITH COLLOID PHENOMENA

A paper by A. V. BLEININGER on the "Ceramic Processes Associated With Colloid Phenomena" was read in his absence. Clays are mixtures of finely divided aluminum silicate, of the $Al_2O_3 2SiO_2 2H_2O$ with granular matter, such as quartz, feldspar, mica, etc., and other colloids like ferric oxide and hydroxide. The particles are of the magnitude of 5μ, or smaller. Clay suspended in water is affected in a pronounced manner by alkalis, salts and acids. The former tend to deflocculate it, the latter two cause coagulation. Both phenomena occur in

phases. Absorption of the basic ion of salts is characteristic, the acid ion remaining in the dispersing medium. Deflocculation is employed in the purification of clays and in the casting process. Measurements of the fluidity of clay suspensions offer the most convenient means of detecting the changes caused by the presence of reagents, though the distinction made by Bingham between viscous and plastic flow must be kept in mind.

The migration of the negatively charged clay particles to the positive electrode within the field of a direct current is the basis of the invention of Schwerin for the purification of clays. The addition of small amounts of NaCl increases apparently the charge of the clay particles and facilitates their deposition. The removal of the impurities from clay is, however, not accomplished through the electrical separation but independent of the latter by previous treatment with NaCl.

The plasticity of clays is associated with flow under pressure and a finite yield point as distinguished from viscous flow showing zero yield point, as proposed by Bingham. The water content, contraction on drying and the capillary flow of water to the surface of the clay are affected by the presence of electrolytes, especially those whose bases show higher valences.

Upon drying and retempering, clay shows more or less of a "set," associated with decreased plasticity, the more pronounced the higher the temperature. Completely dried and dehydrated clay is exceedingly hygroscopic and absorbs vapors with avidity. Dehydrated clay also possesses the properties of a catalyst in certain reactions and combines with bases like calcium hydrate at atmospheric temperature. Dehydration is associated with increase in volume and, of course, is endothermic.

In the firing of clay, contraction of the external volume takes place due to the effect of surface tension and the lowered viscosity upon heating. With maximum contraction and closing of the pore space the state of vitrification is reached. The mass of the clay itself undergoes expansion upon heating irrespective of the external contraction. The relation between temperature, time and contraction is a most valuable one for expressing the heat work done upon clays and other silicates and oxides. Vapor pressure likewise is a probable factor in the condensation of substances like magnesia, coal, carbon, etc., or in mixtures of inert oxides with those of higher vapor tension. The end result of the heating process tends toward the partial elimination of the colloid and the substitution of the anisotropic phase.

Prof. W. D. HARKINS followed with a brilliant address on surface energy, and the symposium was concluded by an appeal from ARTHUR W. THOMAS of Columbia University for reforms in colloid nomenclature.

Electron Society

The Electron Society was organized in December, 1919, to foster researches that may lead to the discovery of an electron formula of the physical or mechanical universe. Meetings are held once a month (excepting July and August) at the Engineering Societies Building, New York City, and are followed by informal round-table discussions of Einstein's theory, Newton's law, behavior of electrons, planetary motion, absolute motion, conservation of energy, etc. For information as to membership, dues, etc., address E. M. V. Leewah, secretary, Engineering Societies Building, New York.

Secretary Alexander Recommends Saving of All Waste Paper

In referring to his recent appeal for the conservation of waste, Secretary of Commerce Alexander made the following statement, urging the saving of all waste paper:

Following my appeal of last week to save waste and turn it back into the channels of trade, I wish to call attention to the importance of saving all waste paper. Attention has been called quite a number of times lately to the vital shortage in paper, and if the general public could realize how a shortage of paper affects its daily life I feel sure that a saving and utilization of all waste paper would be made.

Many of the better grades of waste paper are used as pure substitutes for ground wood pulp and are used in making all kinds of book, bond, ledger and writing papers. If this kind of waste was not used to some extent, there would exist an even greater shortage of wood pulp from which most of our printing papers and newsprint paper is made. The waste paper used in the above list consists of old magazines, periodicals, books, and all kinds of printed matter in general. Every pound of this waste that is saved and marketed prevents the use of original wood pulp made direct from our trees.

The largest tonnage of waste paper is called "common mixed," and consists of any and every sort and scrap of paper, such as newspapers, waste from the offices, stores, public buildings, and the homes. The chief use of this kind of waste is for paper boxes, roofing and building boards, paper shipping containers (which carry up to 100 pounds of freight or express), and wrapping paper. More than 2,000,000 tons of ordinary waste paper is used for boxes and shipping containers alone. The public is so accustomed to having its goods in paper boxes that it would be dumfounded to find their use seriously curtailed, and this is what will happen if we do not look more toward the utilization of waste. The use of waste papers for this purpose prevents the consumption of over 1,000,000,000 ft. of lumber annually and is increasing daily. The utilization of waste must keep pace with this to prevent a direct use of our trees for the wood pulp. At the present time there is very little original wood pulp used for paper-board boxes.

In addition to the saving of trees in the making of paper board, there is another very great saving of lumber through the use of paper "shipping cases," which are used instead of wood boxes. Reports show that it would require more than half a billion feet of lumber annually to replace the "paper" shipping cases now used by almost every manufacturer in the United States.

In most towns and cities there are dealers in waste paper and other salvageable material such as rags, rubber, metals, etc., who will pay a fair price for what otherwise would be thrown away or burned.

The Department of Commerce still has on hand a limited number of two publications on waste reclamation which it will be glad to send to interested persons. These publications will show what one large city has done to develop a city-wide system of waste reclamation for the home, store, and factory, and the other will give some pointers on how to organize and operate the service.

German Export and Domestic Prices for Iron

The Cologne *Gazette* announces that numerous orders for iron bars are being placed in Germany by many countries. Orders from Belgium, France, Italy and Holland are especially numerous and price seems to be a minor consideration. The *Gazette* sees in this dependence on the German iron industry a means of improving mark exchange, and gives the following list of prevailing export prices: For exports to Belgium, 1,225 francs per ton; to Holland, 230 florins; to Switzerland, Italy and Greece, 500 Swiss francs; to Spain, 500 pesetas; to Sweden, 415 crowns; to Norway, 450 crowns; and to Denmark, 500 crowns. These prices are much higher than those fixed for domestic deliveries, which range from 2,620 to 2,900 marks per ton.

Abstracts of Papers Read at the Fifth Annual Meeting of T.A.P.P.I.

Pulp From Cottonseed Linters—Fuel From Waste Sulphite Liquor—Soda Salts From Black Ash—Limestone for Bisulphite Liquor Manufacture—A Revolution in Paper Machine Drive—Liquid Sulphur Dioxide in Sulphite Pulp Manufacture

A GENERAL account of the social activities of the recent T.A.P.P.I. meeting was given in the last issue of CHEMICAL & METALLURGICAL ENGINEERING. Their technical sessions were no less valuable and interesting, as may be surmised from the abstracts of some of the papers given below.

PULP FROM COTTON LINTERS

Otto Kress and Sidney D. Wells read a paper on "Pulp From Cotton Linters," in which they point out that extensive mill trials on the pulping of cotton linters have demonstrated conclusively that they are far superior in paper-making qualities to hull fiber. The latter material has received considerable investigation during the past year, but the low yields and the comparatively poor quality of the bleached pulp obtained have led investigators to believe that second cut linters offer greater possibilities. This grade of linters can be pulped by the ordinary soda pulp equipment with a chemical consumption not to exceed 10 lb. of caustic soda per 100 lb. of dry fiber, and can furthermore be economically bleached with 2 lb. of 35 per cent bleaching powder. Cotton linter pulp will produce a stronger sheet of paper than hull fiber on account of its greater fiber length and the cost of conversion into paper stock is much lower in proportion to the value of the product obtained.

FUEL FROM WASTE SULPHITE LIQUOR

"Fuel From Waste Sulphite Liquor" was discussed by George Barsky and Ralph H. McKee. Great developments during the last few years in boiler design and boiler practice, the burning of powdered coal, and of oil, have made possible the profitable use of concentrated waste sulphite liquor as a fuel. The solid material of the waste liquor has sufficient fuel value to evaporate the liquor and enough in addition to supply power or steam for other purposes. Owing to the colloidal nature of sulphite liquors, the boiling point does not change appreciably during the course of evaporation and hence it lends itself admirably for use in a thermo-compressor evaporator. In this form of apparatus there is only a small difference of temperature between the heated and the heating side and if operating with 150 lb. steam and connected to a double-effect evaporator (i.e., comprising a triple-effect evaporator, the first effect of which is a thermo-compressor), it is possible to evaporate 5.4 lb. of water per lb. of 150-lb. steam used. This amounts to 0.185 lb. of high-pressure steam as compared to 0.276 lb. of low-pressure steam for quadruple effect. Experiments have been conducted using both raw liquor and air-fermented liquor and the following figures are representative of the results obtained per ton of pulp:

	Raw Liquor	Air-fermented Liquor
Pounds of 150-lb. steam that can be made..	7,450	5,830
Pounds of water that must be evaporated...	12,480	10,000

The steam generated can be used for the development of power in non-condensing steam engines and the exhaust could in turn be used to evaporate the liquor in multiple-effect evaporators. In terms of fuel values the net combustible material in the raw liquor is equivalent to 780 lb. of 14,000-B.t.u. coal and in the fermented liquor, 610 lb. per ton of pulp produced.

EXTRACTION OF SODA SALTS FROM BLACK ASH

Instead of the usual method of extracting soda salts from black ash in leaching cells, George M. Vrostel suggested a more efficient method presenting many decided advantages. His plan is to leach uniformly ground ash on a rotary vacuum filter. The process would be continuous and would make it possible to reduce the volume of the resulting liquor considerably. He also claimed that a more complete extraction is effected and that the process can be controlled to a much greater extent than the ordinary leaching process.

LIMESTONE ANALYSIS AND EVOLUTION FOR BISULPHITE LIQUOR MANUFACTURE

"Limestone Analysis and Evolution for Bisulphite Liquor Manufacture" was discussed by W. E. Byron Baker. In the preparation of bisulphite liquors for the manufacture of sulphite pulp the character of the limestone used is an important factor. The relative degree of success in the operation of the limestone towers is dependent upon certain characteristics in the stone, and the quality of the pulp produced in cooking is influenced by the extent of impurities in the stone. The author outlined detailed methods of analysis for the determination of insoluble carbonaceous matter, silica, insoluble inorganic matter, iron, aluminum oxide, calcium oxide, magnesium oxide, alkali metal oxides, carbon dioxide, sulphur trioxide, sulphur as sulphide, hygroscopic moisture and combined water. In addition to the above it is sometimes desirable to know the mineralogical constitution of the stone, or at least determine the form in which the calcium and magnesium carbonates exist.

REVOLUTION IN PAPER MACHINE DRIVE

"A Revolution in Paper Machine Drive" was described by Stephen A. Staege. He noted that heretofore paper machines have been driven entirely by a mechanical system and the application of a sectional individual motor drive has never met with success. It is not because of any disinclination on the part of the paper industry to accept individual motor drive that the old mechanical systems have been so long continued in use, but because of the inability of the electrical apparatus heretofore available to meet the exacting speed regulation required of this type of sectional drive. The disadvantage of the mechanical system is that it requires

too much space, power, and repairs for its installation, and in the past few years great effort has been concentrated on the problem of so controlling the speed of sectional motor drives that their relative speeds should not vary more than 0.1 per cent. This has been accomplished and it has been demonstrated that with sectional individual motor drive the variable speed line of the paper machine can be driven with approximately half of the power required where mechanical drive is used on account of the great reduction in power losses. It is also possible greatly to increase speed and production.

Advantages of Liquid Sulphur Dioxide in Sulphite Pulp Manufacture

"Advantages of Liquid Sulphur Dioxide in Sulphite Pulp Manufacture" was discussed by Vance P. Edwards. He noted that the production of liquid sulphur dioxide from smelter smoke has long been recognized as a possibility, but previous to the World War no liquid sulphur dioxide from any source was produced in this country. Prior to 1914 the Forest Products Laboratory was using liquid sulphur dioxide obtained from Germany in cylinders of approximately 200 lb. capacity. There are now, however, at least two concerns manufacturing this material on a small scale from the element sulphur and one smelter producing something in the neighborhood of fifty tons of liquid sulphur dioxide per day.

Smelters operating upon pyritic ores discharge gases carrying from 0.5 to 3 per cent sulphur dioxide out of the main stack. However, from certain of the smelting operations, such as sintering, roasting and converting, gas of much higher concentration is obtained. Gas from this source is naturally selected for liquefaction, inasmuch as high concentrations of sulphur dioxide require less total amount of gas per pound of product.

The gas is first cooled, then passed through scrubbers or precipitators which remove nearly all the suspended solids and much of the sulphuric acid mist. After leaving, the gas is passed into absorption towers, where a strong aqueous solution of sulphur dioxide is made. In actual operation the strength of this solution is in the neighborhood of 1 per cent. The dissolved gas is next removed by agitation and heat, then cooled, dried and compressed to 60 to 70 lb., again cooled to 20 deg. C., at which temperature and pressure it is liquefied. Depending upon local conditions, it is estimated that liquid sulphur dioxide can be produced at a cost of about $10 per ton. To this must be added tank car equipment and transportation charges.

The value of liquid sulphur dioxide for acid making and its advantages in cooking are to a certain extent unknown quantities, though it can certainly be assumed that it is worth in excess of its equivalent weight in sulphur. That is, if sulphur cost $24 a ton at the mill, liquid sulphur dioxide is worth more than $12. Neglecting any of the chemical advantages due to the use of liquid sulphur dioxide, it is estimated that the lower handling charges and simplified mechanical operation alone would permit $15 being paid for this material.

In addition the author feels that liquid SO_2 has other and more important advantages over elemental sulphur when used in acid making. Briefly enumerated, these are: freedom from sulphuric acid and sublimed sulphur; elimination of burners and coolers; smaller piping necessary, and that may be of iron; stronger acid and shorter make-up time due to the more concentrated gas, and in the summer the acid plant may be independent of cooling water.

Sulphuric acid most frequently causes a loss of 20 lb. of sulphur per ton of pulp in addition to the cost of the lime which is precipitated. On the above basis this amounts to 35 lb. of calcium oxide per ton. The material loss from these items alone can easily amount to 35c. a ton of pulp made, and in many cases more. Indirect and more serious losses are incurred due to the cost of cleaning and the rapid depreciation of such equipment. A saturated solution of clear cooking acid can carry about 20 lb. of calcium sulphate in the liquid per ton of pulp. This is precipitated at cooking temperatures and could easily form a protective coating over the ends of the chips, effectually plugging the pores and seriously retarding penetration by the cooking acid, thus causing unevenly cooked pulp.

The relative advantages arising from the use of stronger acid in cooking have been repeatedly proved. It would be expected that increased yield, due to more even penetration, would be obtained, together with a shorter cooking time and lower bleach consumption. Such experiments as Mr. Edwards has made indicate that an acid containing double the SO_2 concentration usually employed decreases the time by 25 per cent, and increases the normal yield 10 per cent. Using the above as a basis of calculation, a digester making two cooks a day would add three cooks a week to the next output. The increased saving due to greater yields would amount to about 100 lb. on a cord of wood; in other words, one would be getting 1,100 lb. for the present cost of 1,000 lb. In the case of a 10-ton digester, the weekly output due to shorter cooking would be increased from 120 to 150 tons, while the higher yield would add 15 tons, bringing the total to 165 tons, or a 37½ per cent increase.

Liquid sulphur dioxide upon expansion absorbs 94 B.t.u. per lb., and it is conceivable that the cooling water for relief lines could be used to supply at least part of this heat. Also it would be possible to pass the cooled relief gases directly into the acid system, regulating the flow of gas from storage tanks to suit conditions. This, of course, would be impossible if the gas supply was obtained from burners. The reclaimed liquor would be collected in a separate tank and there would be no raw acid tanks.

Against these advantages must be charged the various alterations necessary and the enlarging of the recovery system to handle the greatly increased amount of gas from the digesters.

Production of Metals in Mexico Since 1916

Statistics showing the production of metals in Mexico from 1916 to September, 1919, have been published in *Iniciativa de la Ley de Ingresos* for the fiscal year 1920. The following table, taken from the publication mentioned, gives the production for 1916, 1917, 1918, and 1919 (January to September) (1 kilo = 2.204 lb.):

Metals	1916 Kilos	1917 Kilos	1918 Kilos	1919 (Jan.-Sept.) Kilos
Gold	11,748	23,543	25,313	17,208
Silver	926,142	1,306,988	1,944,512	1,462,255
Copper	28,411,218	50,985,923	70,223,454	38,170,209
Lead	19,970,986	61,121,752	98,837,154	50,533,765
Zinc	37,449,226	14,757,333	20,698,995	6,499,060
Antimony	828,767	2,646,544	3,268,546	470,778
Tin	292	9,214	13,537	1,568
Tungsten	12,250	187,637	149,486	21,969
Molybdenum	....	....	27,371	1,767
Manganese	....	73,387	2,878,383	2,137,484
Mercury	....	33,132	163,598	85,309
Arsenic	....	1,284,820	1,881,011	1,611,250
Amorphous graphite	470,313	420,046	6,190,849	3,758,714

Consumption of Inorganic Nitrogen in the United States

A Study Prepared in the Nitrate Division of the Ordnance Department in an Effort to Forecast the Future Consumption of Inorganic Nitrogen in the United States, Based on Conditions During the Last Twenty Years

By Major D. P. GAILLARD
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Editor's Note. This is the first of two articles prepared by Major Gaillard. The second will discuss in detail the supply of inorganic nitrogen in the United States, and will contain a summary in which the probable consumption and expected supply will be compared.

THE consumption of nitrogen has been increasing so rapidly, not only in the United States but throughout the world, that in order to study it intelligently it is not satisfactory to consider merely one year, and study conditions during that year, but the trend of conditions from year to year must also be studied.

Statistics are available giving the total supply of nitrogen in this country during each of the last twenty years. As to just how this nitrogen was used, equally reliable information is not available, but a fairly accurate estimate can be made for each year. There are sometimes appreciable stocks of nitrogenous materials carried over from one year to be used up in the next. In this study, however, the consumption for each year has been assumed to equal the supply for that year. If in one year by this method the consumption is too high, the next year it will be correspondingly too low, and any relatively small errors so introduced will neutralize themselves in studying the general trend of conditions over a period of years.

The consumption of nitrogen may be broadly divided into three parts, the agricultural, the industrial and the military. The nitrogen exported must also be included with the consumption.

In this study each of these broader divisions will be considered separately, leading finally to a consideration of the resultant conditions as to total consumption and supply.

Nitrogen Consumed in Agriculture

General

Nitrogen, together with phosphorus and potassium, is essential to the growth of plant life, and all fertilizer contains one or more of these elements, and most fertilizers contain all three. Of these, nitrogen is as important as any and, in the proportion ordinarily used, is the most expensive of the three.

In the United States it is customary for the fertilizer manufacturer to mix, in various given proportions, materials containing these three elements, which are bagged and sold as mixed fertilizer to the farmer, probably 80 per cent of the fertilizer used in this country being in the form of mixed goods.

The nitrogen in fertilizers is derived from two classes of materials: organic, or animal and vegetable materials, and inorganic, or mineral and chemical materials. The most important organic materials are cottonseed meal and animal tankage, the latter a waste product of the meat-packing industry. Other organic materials used are garbage, fish scrap, hair, horns, scrap leather, etc. The inorganic materials are Chilean nitrate and sulphate of ammonia—the form in which nitrogen is usually recovered from the coke ovens; to a much less extent cyanamide—one of the forms in which nitrogen is fixed from the atmosphere—and a very small amount of other chemicals.

In 1917, according to statistics gathered by the Department of Agriculture, a little less than half of the total nitrogen in mixed fertilizers was furnished by inorganic materials, Chilean nitrate supplying about three-fifths of this, sulphate of ammonia about one-third and miscellaneous materials the remainder. If we include the Chilean nitrate sold for separate application to the soil, about 60 per cent of the nitrogen sold for fertilizer would come from inorganic materials. Of the organic nitrogen about equal quantities were furnished by cottonseed meal and tankage, the two together supplying about 60 per cent of the organic nitrogen.

Use of Fertilizer in the Past

Commercial fertilizers first began to be used in this country about fifty years ago, and their use has increased steadily since that time. By 1904 the value of the fertilizers sold was ten times their value in 1869. From 1904 to 1914 the growth was very much more rapid, the value of the products in 1914 being three times, and the total tonnage of fertilizers manufactured being approximately two and a half times, the amounts in 1904.

Statistics available on the manufacture of fertilizer in the United States in the past are as follows:

FROM U. S. CENSUS STATISTICS

Year	Tons of Fertilizer Manufactured	Per Cent of Increase for 5-Yr. Period	Per Cent of Increase for 10-Yr. Period	Per Cent of Increase for 15-Yr. Period
1899	2,887,000	....	....	....
1904	3,592,000	24	....	....
1909	5,618,000	57	94	
1914	8,432,000	50	135	192

FROM THE AMERICAN FERTILIZER HANDBOOK AND FROM DEPARTMENT OF AGRICULTURE BULLETIN NO. 798

1909	4,900,000	1914	*7,626,000
1910	5,737,000	1915	5,783,000
1911	6,332,000	1916	5,583,000
1912	6,105,000	1917	6,592,000
1913	6,760,000	1918	†7,011,000

* 56 per cent increase over 1909. † 26 per cent increase over 1916.

It is to be noted that in the ten years prior to 1914 the use of commercial fertilizers more than doubled, the rate of growth in each 5-yr. period being substantially the same. 1915, owing to the influence of the war, with the abnormally low price received for the cotton crop and the demoralization of the fertilizer industry, the consumption of fertilizer decreased very

considerably. There was a still further slight decrease in 1916, but since that time the consumption has been increasing at approximately the rate that prevailed from 1909 to 1914. Exact figures for 1919 are not yet available, but it is estimated that the consumption last year was in the neighborhood of 7,500,000 tons, and while the 1920 consumption may actually be smaller than that last year, it will be due to the extreme shortage that has prevailed and is prevailing in all fertilizer materials, a shortage that has caused the abnormally high price of fertilizer materials now obtaining. It is evident that the demand for fertilizer is not being met and the present consumption is a matter of present supply rather than of present demand.

Although the South has been and is the principal user of fertilizer, in the last few years having taken about 60 per cent of the total production, the Middle West has shown the largest rate of growth from 1910 to 1914 and since 1916, and now uses over 10 per cent of the total. New England, which uses about 6 per cent, has shown the next most rapid growth, and the Middle Atlantic States, using a little less than 20 per cent, have a growth slightly greater than that of the South.

Need for Fertilizers

This very rapid growth in the use of fertilizers in the United States is only repeating what has taken place in Europe. As the land has become depleted, the crop yields have fallen off and to bring the soil back to its original fertility it has been necessary to supply fertilizer to make up the deficiency. This tendency was first felt in the South and the East, as the soil there had been under cultivation for a longer period, and was particularly marked in the South, where conditions made rotation of crops very difficult and where cotton is usually planted on the same land year after year. A large part of the soils in the corn belt of the Middle West is now or will soon become depleted in nitrogen and the use of fertilizers in that section must inevitably increase even faster in the future than in the past.

If the price of fertilizer were low enough, there is for practical purposes almost no limit to the amount that could be advantageously used. It has been estimated by Dr. Lipman, director of the New Jersey Agricultural Experiment Station, that the annual loss of nitrogen from all land under cultivation in the United States which is not replaced by manure, by the nitrogen supplied by plowing under leguminous crops, by atmospheric precipitation in the form of rain and snow and by the present use of commercial fertilizer amounts to between 3,000,000 and 4,000,000 tons of nitrogen, to replace all of which would take from 15,000,000 to 20,000,000 tons of sulphate of ammonia, or from 150,000,000 to 200,000,000 tons of ordinary commercial mixed fertilizer.

It would not pay now or in the immediate future to use fertilizer to any such extent on all of the land under cultivation, but these huge figures represent the upper limit to the use of nitrogen in fertilizer, and show how far from that limit the present consumption is.

At present it will pay to use fertilizer in many cases where it did not pay before the war; the value of land in most agricultural sections of the country has increased very considerably; the cost of farm labor has increased even more rapidly; and the value of the farm products in general is much higher than before the war. The use of fertilizer which causes a greater production per unit of land and per unit of farm labor, provided this fertilizer can be secured at a reasonable price, must therefore inevitably increase, and, assuming that a sufficient supply is available, it is entirely reasonable to assume that it will increase even faster than it did before the war.

Future Use of Fertilizers

It will be seen that from 1899 to 1914 the consumption of fertilizer in the country practically tripled, an increase substantially equivalent to an increase each year of 7½ per cent over the previous year. The growth during the last five years of this period was at an even greater rate, and since the slump in 1915 and 1916 the recovery has been practically at this same rate. It is therefore conservative to assume, in view of the factors mentioned before, which favor the increasing use of fertilizer even more than was the case before the war,

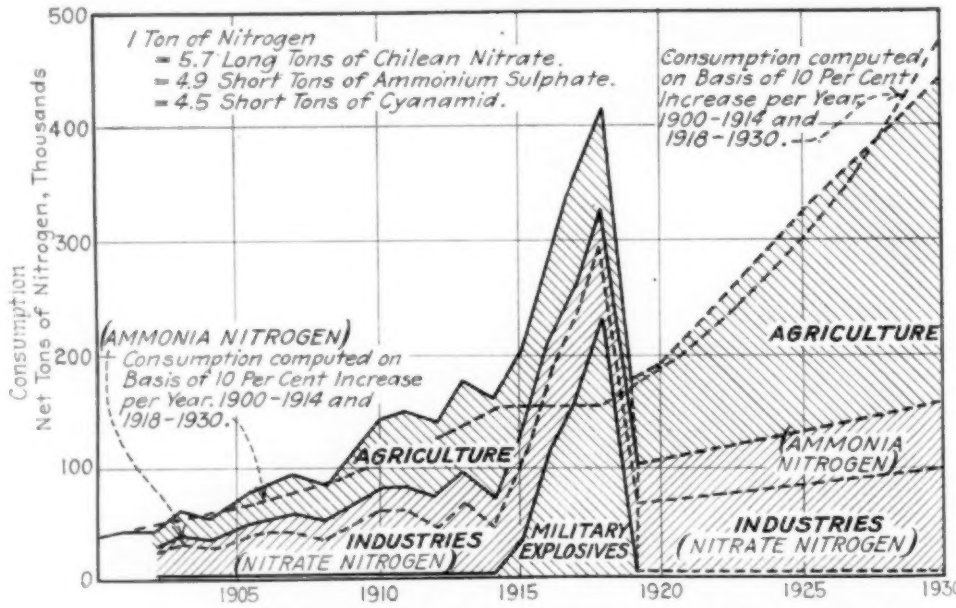

CHART SHOWING CONSUMPTION OF NITROGEN IN THE UNITED STATES

that this growth will continue at this pre-war rate of 7½ per cent per year at least until 1924; that is, that there will be an average increase each year in the next five years of 7½ per cent over the preceding year. This would give a total fertilizer consumption for 1924 of 10,500,000 tons, a figure which, it is to be noted, is only about 25 per cent higher than the figure as actually reported by the census statistics for 1914—ten years earlier. The rate of growth from 1924 to 1930 has been assumed to continue uniformly at a somewhat slower rate, an increase little less than 800,000 tons a year, which gives for 1930 a total consumption of 15,200,000 tons.

All of the organic nitrogenous materials are the byproducts of other industries, principally the meat-

packing and cottonseed oil industries. Although there has been a steady growth in these industries in the last twenty years, this growth has not been nearly so great as the growth in the consumption of fertilizer. Moreover, there has been a steadily increasing use both of cottonseed meal and animal tankage for feeding purposes, this use increasing especially rapidly in the last three or four years. The net result of this has been to make available for fertilizer use a slowly increasing amount of organic nitrogen up to two or three or four years ago, since which time there has been a considerable decrease—a decrease especially marked in the last year. During the past few months, garbage tankage from cities like Pittsburgh and Baltimore, which was formerly used exclusively for fertilizer purposes, has been entirely withdrawn for feeding purposes.

It is to be noted that at present the price of cottonseed meal is approximately the same as corn meal, about three-fourths that of oatmeal, and about two-thirds that of wheat flour. At these relative prices, it will naturally be evident why cottonseed meal is going into feed rather than into fertilizer.

Figures compiled by the Department of Agriculture show that in 1917 and 1918 about half of the high-grade animal tankage was being used for feed and about two-thirds of the cottonseed meal. Since then this proportion has undoubtedly increased. That these materials are now primarily feeds and only secondarily fertilizers is shown further by the course of their prices in the last year or so, during which time their prices have been controlled by the feedstuff market rather than by the prices of their competitive fertilizer nitrogenous materials, Chilean nitrate and sulphate of ammonia.

Increasing Use of Inorganic Nitrogen in Fertilizers

Some figures may help to show just how these tendencies have affected the proportions of organic and inorganic nitrogen used in fertilizers. In 1899, statistics indicate, about five-sixths of the nitrogen in mixed fertilizers, together with that used separately, came from organic nitrogenous materials; in 1904 about three-quarters; in 1909 slightly over half; and in 1914 slightly under a half, and in 1919 somewhat over a third. It is estimated that in 1924 this proportion will not be more than a fifth, and in 1930 not more than a tenth, as in 1924 there will be available not more than 45,000 tons of nitrogen from organic sources, about 60 per cent of the amount available in 1917, and in 1930 not more than 28,000 tons of nitrogen, about 40 per cent of the amount available in 1917.

Future Use of Inorganic Nitrogen

The estimated consumption of 10,500,000 tons of fertilizer in 1924 will require approximately 217,000 tons of nitrogen, not more than 45,000 tons of which can come from organic materials, leaving 172,000 tons of inorganic nitrogen to be supplied.

The estimated consumption of 15,200,000 tons of fertilizer in 1930 will require approximately 315,000 tons of nitrogen, not more than 30,000 tons of which can come from organic materials, leaving 285,000 tons of inorganic nitrogen to be supplied.

In other words, inorganic nitrogen must supply not only all the nitrogen requirements in addition to those as present existing, but must replace in 1924 about 40 per cent, and in 1930 over 60 per cent of the organic nitrogen now being used.

Nitrogen Consumed in Industries

Uses of Nitrogen in Industry

In the chemical industries of the country, in which is included the manufacture of domestic explosives, nitrogen plays a very important part. This nitrogen is consumed in two forms, as nitric acid made from Chilean nitrate and ammonia derived from the gas works and the byproduct coke ovens. At present about two-thirds of the nitrogen is consumed in the form of nitrate and about one-third in the form of ammonia.

Somewhat more than half of the nitrate used goes into the manufacture of industrial explosives, such as dynamite, blasting powder, etc., which are used not only for practically all mining and quarrying operations but to a rapidly increasing extent for road building, clearing land, digging ditches, and other labor-saving purposes. Somewhat less than half of the nitrate goes into other chemical industries, principally the production of the several nitrocellulose products which include artificial leather now almost universally used for automobile upholstery, photographic films, imitation ivory, and all forms of celluloid. It is also used to some extent in the glass industry.

Of the ammonia approximately one-quarter is used in connection with the operation of cold storage plants and for the manufacture of artificial ice, about one-third is used in the quantity production of staple chemicals, principally soda ash, ammonium chloride and sodium cyanide, about one-eighth goes into the explosive industry, principally for the manufacture of ammonium nitrate, and the remainder is used for miscellaneous purposes including the manufacture of household ammonia.

Estimates of Past Consumption

In estimating the amount of Chilean nitrate used in the industries in each of the several years the estimated amount consumed in fertilizers has been deducted from the imports for that year and the remainder taken to be the nitrate used in the industries. Of course, during the World War the military consumption has also been deducted.

In the case of ammonia, for the most of the years statistics are available from the U. S. Geological Survey, giving the total production of ammonia from byproduct coke ovens and giving that part of the production which is in the form of sulphate of ammonia. The difference between these two plus the entire ammonia output of the gas works has been taken to be that portion of the ammonia consumed in chemical industries. The relatively small part of the ammonia production from gas works which goes into the manufacture of sulphate of ammonia may be assumed, without serious error, to balance that small part of the sulphate going into the chemical industry.

The figures thus determined show that there was from 1902 to 1914 a steadily increasing use of both nitrate and ammonia in industry, the use of nitrate increasing each year by approximately 20,000 short tons (17,850 long tons), containing 3,125 tons of nitrogen, and the use of ammonia increasing each year by approximately 2,125 tons, containing 1,750 tons of nitrogen. The normalized consumption of ammonia in industries during 1919 is estimated at 42,500 tons, containing 35,000 tons of nitrogen, a figure obtained by assuming the pre-war growth to have continued to 1919. In the case of nitrate, however, the normalized consump-

tion in 1919 has been taken to be 400,000 short tons of Chilean nitrate, containing 62,500 tons of nitrogen, approximately the normalized consumption in 1914, and somewhat greater than the actual consumption in 1913. By normalized consumption is meant the consumption assuming that in 1919 the nitrogen-using industries were normally busy. The total consumption in industries of both nitrate and ammonia estimated for 1919 is then 97,500 tons of nitrogen.

The use of both nitrate and ammonia has been assumed to continue to increase from 1919 to 1930 at the pre-war rate of about 4,875 tons of nitrogen a year. It is believed that this is a very conservative estimate, as this rate of increase at the beginning of the period amounts to only 5 per cent and at the end of the period to only 3½ per cent a year. On this basis there would be consumed in industry in 1924 approximately 500,000 tons of Chilean nitrate and 53,000 tons of ammonia, together containing 120,000 tons of nitrogen, and in 1930 the estimated consumption would be 600,000 short tons of Chilean nitrate and 64,000 tons of ammonia, together containing 150,000 tons of nitrogen.

In the above discussion it has been assumed that in the future the requirements for ammonia nitrogen and for nitrate nitrogen are distinct, but developments during the war have shown that the conversion of ammonia nitrogen to nitrate nitrogen is entirely practicable and should ammonia be relatively more plentiful than nitrate and, therefore, its price appreciably lower, there is no question that a considerable part of the requirements for nitrate nitrogen would be supplied by the conversion of ammonia nitrogen.

Nitrogen Consumed in Military Explosives

Prior to the outbreak of the World War the total consumption of nitrogen in this country for military explosives increased from a few hundred tons in 1900 to between 1,000 and 2,000 tons in 1914. Exact statistics on the consumption during this period are not readily obtainable and since the use of nitrogen for this purpose is such a very small part of the total consumption, exact figures are not necessary.

In the latter part of 1915 the manufacture of explosives for the Allies began, and from then on until the armistice, in 1918, the production of military explosives increased at a tremendous rate in this country. In 1918, the year of maximum consumption, it is estimated that somewhat less than 150,000 tons of nitrogen was actually consumed in the manufacture of military explosives. At the same time a military reserve stock of Chilean nitrate was slowly being built up with the object of ultimately accumulating a sufficient quantity to last for six months should all imports be cut off; and a smaller stock of ammonium sulphate was being accumulated for the manufacture of ammonium nitrate. As a result, at the end of 1918 approximately 80,000 tons of nitrogen was on hand in the form of these stocks of material. In other words, the accumulation of these essential reserves, together with the actual consumption, required in 1918 in the neighborhood of 230,000 tons of nitrogen, equivalent to more than 1,300,000 long tons of Chilean nitrate, a quantity of nitrogen more than a third greater than the consumption for all purposes in the highest year before the World War.

The future consumption of nitrogen in military explosives so long as the United States is not involved in war will be but little larger than was the case before the war, and in fact, it may actually be even less owing to the large amounts of powder and explosives now in storage. In any event the peace-time consumption of nitrogen for military explosives will be a negligible part of the total consumption. So long, however, as this country is so largely dependent on imported nitrogen, conditions will be similar in case of a future war, and nitrogen will have to be supplied not only to meet the actual consumption, but to establish a sufficient reserve to safeguard against an enemy completely cutting off all imports.

Nitrogen Exported

In the past but little inorganic nitrogen has been exported, as this country itself has been such a heavy importer of nitrogen. A large part of the little inorganic nitrogen exported was contained in mixed fertilizers manufactured here.

However, since the practical cessation of sulphate exports from Europe, and particularly in the last year, the United States has been exporting a fairly considerable amount of sulphate of ammonia to the West Indies and to the Far East. Although no statistics are available, it has been estimated that the exports last year of inorganic nitrogen may have amounted to nearly 10 per cent of the total domestic consumption.

The question as to what may be expected in nitrogen from this country in the future is most uncertain and in this study no allowance will be made for any future exports. Undoubtedly there will be some exports, and it is very desirable that there be exports both from a commercial and a military point of view, but as these will tend to increase the requirements for nitrogen in the United States and serve only to accentuate the deficiency of the domestic supply, they will not be included.

Relation Between Mechanical Hardness and Grain Size of Carbon Steels

An investigation on this subject by the Bureau of Standards has now been completed. It shows that there is no simple relation between grain size and hardness in carbon steels such as exists, for example, in the alpha brass and other one-constituent alloys. Grain size is a factor of minor importance. The amount of distribution of the structural constituents determines the hardness to a far greater extent. The work already completed throws some light incidentally upon the magnitude of the stressing of low-carbon steel by cooling and work in order to effect the subsequent growth of grain upon annealing below the critical temperature. It is planned to extend this investigation to include a study of the effect of grain size upon other mechanical properties.

Japanese Encouraging Beet-Sugar Industry in Manchuria

As the annual sugar production of Japan is little more than half of the amount locally consumed, and as the action of Java in prohibiting the exportation of sugar for the next six months emphasized the possibilities of future shortage of sugar in Japan, the Japanese are realizing the necessity for developing a more dependable source of supply, says the *North China Commerce*. To this end they have offered rewards to the farmers of Manchuria for large crops of sugar beets, thus encouraging them to plant beets instead of customary crops.

Microstructure of Iron and Mild Steel at High Temperature*

Pronounced Decarburization Occurs When Metal Is Heated in Vacuo, Consequently Heat-Etching of Polished Surfaces Represents Largely Structure at Surface—Nature of the Surface Patterns Is Also Discussed

By HENRY S. RAWDON and HOWARD SCOTT
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THE method of demonstrating the structure existing in a metal or alloy at high temperatures, by etching a polished sample after it has been heated to the desired temperature, is quite familiar to metallographists. The usual procedure[1,2] is to heat the specimen, previously polished for microscopic examination, to the desired temperature, in a neutral atmosphere (hydrogen or nitrogen), then admit the etching gas (chlorine, hydrochloric acid or similar gas) for a few seconds, and finally, after flushing out the etching gas with the neutral one, cool the specimen in the neutral atmosphere. The pattern produced by etching at a definite temperature is usually taken as a record of the microstructure prevailing at that temperature. It has frequently been pointed out that changes in composition of the surface metal occur during the preliminary heating in the neutral atmosphere, so that the appearance produced by the etching at high temperature may not exactly represent the condition of the interior of the specimen. To overcome this uncertainty, the heating has sometimes been done in vacuo,[3] the etching gas being admitted when the desired temperature was reached, then pumped out and the specimen cooled in vacuo.

The studies of Rosenhain, Humfrey, and other workers[4,5,6,7,8] demonstrate that surface changes in the steel occur even when the specimens are heated in vacuo. Such changes in themselves are sufficiently pronounced to record, in the appearance of the surface, the microstructure prevailing at the temperature at which the change took place. The surface configuration or pattern thus produced, to which various names, "heat-relief," "heat-etching" and "vacuum-etching," have been applied, has been explained by Rosenhain as being due to volatilization of the surface metal. This is more marked along the crystal boundaries than over the face of the crystal itself. The change in composition of the layer immediately adjacent to the surface of a steel sample when heated in vacuo or in a neutral atmosphere has also usually been attributed to volatilization. Howe[9] has offered an entirely new and striking explanation for this phenomenon, namely, that the change in composition of the surface layer is only local and the average composition of the specimen does not change. Upon cooling a sample of steel from a high temperature, the free constituent (ferrite or cementite as the case may be) is expelled to the outside of the mother austenite crystal and thus to the surface of the specimen in those crystals which form the exterior. By repeated heatings, the layer of expelled ferrite (in the case of low-carbon steels) is augmented until the specimen has the appearance of being decarburized at the surface.

The examinations here described were made for the purpose of showing to what extent the change in composition of the surface layer, which usually accompanies heating in vacuo, affects the results of tests which may be made to reveal the microstructure existing at high temperatures. The results also throw some additional light upon the nature of the change in composition of the surface layer and also upon the formation of the surface pattern under "heat-relief" etching.

Method of Revealing Structural Changes Occurring at High Temperatures

Pure iron and low-carbon steel were chosen as typical materials for demonstration, since both materials show pronounced changes in structure accompanying some of the transformations which occur upon heating. The normal structure of each is familiar, and the microstructure at high temperature has been demonstrated by means of the etching method.

Pure Iron

A remelted electrolytic iron having the following composition was used: Carbon, 0.03 per cent; sulphur, 0.002 per cent; silicon, 0.009 per cent. By thermal analysis, the material was shown to have the following thermal characteristics: Ac_2, 768 deg.; Ac_3, 910 deg.; Ar_3, 900 deg.; Ar_2, 768 deg. C. The specimens, which were of the size used for thermal analysis (approximately 3 g.), were mounted on the end of a platinum platinum-rhodium thermocouple and heated in the evacuated tube of a differentially heated furnace of the Rosenhain type[10] to the following temperatures: 950 deg. C., above A_3; 880 deg. C., between A_2 and A_3; 700

*A paper read at the winter meeting of the American Institute of Mining and Metallurgical Engineers, February, 1920.

[1] N. Gutowsky: Über die Structur des Stahlen bei hohen Temperaturen: *Metallurgie* (1909), vol. 6, p. 743.

[2] H. Hanemann: Über das Atzen in Hoher Temperatur. *Inter. Zeit. Metallographie* (1912-13), vol. 3, p. 176.

[3] N. Tschischewsky and N. Schulgin: *J. Iron and Steel Inst.* (1917), vol. 95, p. 189.

[4] W. Rosenhain and J. C. W. Humfrey: "The Crystalline Structure of Iron at High Temperature." *Collected Researches*, Natl. Phys. Lab., Teddington (1910), vol. 6, p. 189.

[5] W. Rosenhain and J. C. W. Humfrey: "The Tenacity, Deformation and Fracture of Soft Steel at High Temperatures." *J. Iron and Steel Inst.* (1913), vol. 87, pp. 219-315.

[6] J. C. W. Humfrey: "The Intercrystalline Fracture of Iron and Steel." *Collected Researches*, Natl. Phys. Lab., Teddington (1913), vol. 10, p. 113. Also Iron and Steel Inst., *Carnegie Sch. Mem.* (1912), vol. 4, p. 80.

[7] W. Rosenhain and D. Ewen: "Intercrystalline Cohesion in Metals." *Collected Researches*, Natl. Phys. Lab., Teddington (1913), vol. 10, p. 91. Also *J. Inst. Metals* (1912), vol. 8, p. 149.

[8] Adolphe Kroll: "The Crystallography of the Iron-Carbon System." *J. Iron and Steel Inst.* (1910), vol. 81, p. 304.

[9] H. M. Howe: "The Position of Ae_3 in Carbon-Iron Alloys, Discussion." *Trans.*, A. I. M. E. (1913), vol. 47, p. 659.

[10] H. Scott and J. R. Freeman, Jr.: "Use of Modified Rosenhain Furnace for Thermal Analysis." *Bull.* A. I. M. E., No. 152, (August, 1919). A description of the furnace and the auxiliary apparatus is given. See also page 811 of this issue for synopsis.

deg. C., below Ac_1 (of steels). In each case the specimen was held for approximately 30 min. at the maximum temperature and then cooled in the evacuated furnace at an approximate rate of 0.15 deg. per second by moving the specimen to the cold end of the tube. The surface of the specimens, after heating, showed no evidence of oxidation. In most cases, particularly those heated to the highest temperatures, the surface had a slightly roughened or matte appearance.

Fig. 1 shows the surface pattern produced by heating the iron above the Ac_3 transformation. Two distinct patterns are to be seen superimposed one upon the other. One of the patterns is similar in appearance to that of pure iron as ordinarily etched at room temperature; the other network prevailing above A_3 contains numerous straight lines and many of the enclosed "grains" have the appearance of twinned crystals. This is clearly shown at *A-A* and *B-B*. The long narrow crystal is the twinned layers of a much larger crystal. Another network, outlining a second system of grains, is superimposed upon the twinned crystals.

The network delineating the straight-sided polyhedral twinned crystals is a record of the structure of the γ iron, i.e., the form existing above the A_3 transformation. The second network belongs to the crystal structure prevailing below this transformation, as seen in specimens heated to a temperature below A_3. Only one network is developed under such treatment, and this is identical with the second pattern of specimens heated above A_3. The specimen shown in Fig. 2 illustrates this, and also shows that no characteristic crystal form corresponds to the so-called β range. The appearance is the same as that of specimens heated to a temperature well below A_2 (Fig. 3) and also of samples polished and etched under ordinary conditions. This observation confirms that of Rosenhain and Humfrey, in this respect.

Fig. 3 shows the surface of a polished specimen heated to 700 deg. C. The network outlining the arrangement of the crystals appears faintly even at this relatively low temperature.

The surface of freshly heated specimens often has a "matte finish" appearance and, when viewed at an oblique angle, is seen to be considerably roughened. The volatilization occurring at high temperatures, as shown in Fig. 1 accounts partly for the matte finish. It was noted that the volatilization develops rather well defined "etching pits" on the surface, by means of which the structural orientation within the twin crystals relative to the mother crystal is plainly shown [in micrographs not reprinted]. The roughened appearance is largely due to a "buckling" of the surface of the individual crystals. In Fig. 4, a section perpendicular to the polished surface which was exposed to the heat, is demonstrated the distortion that occurs: the boundary, i.e., the trace of the polished flat surface, originally rectilinear, now consists of a series of undulations. Specimens heated to a temperature a little below A_3 show an irregular branching network within the grains themselves (Fig. 2). This is often seen in pure iron after ordinary etching for microscopic examination, particularly if the sample has been strongly heated previously, for example, specimens which have been heated several times for thermal analysis curves. Whether this bears any relation to the β change has not yet been determined.

Low-Carbon Steel

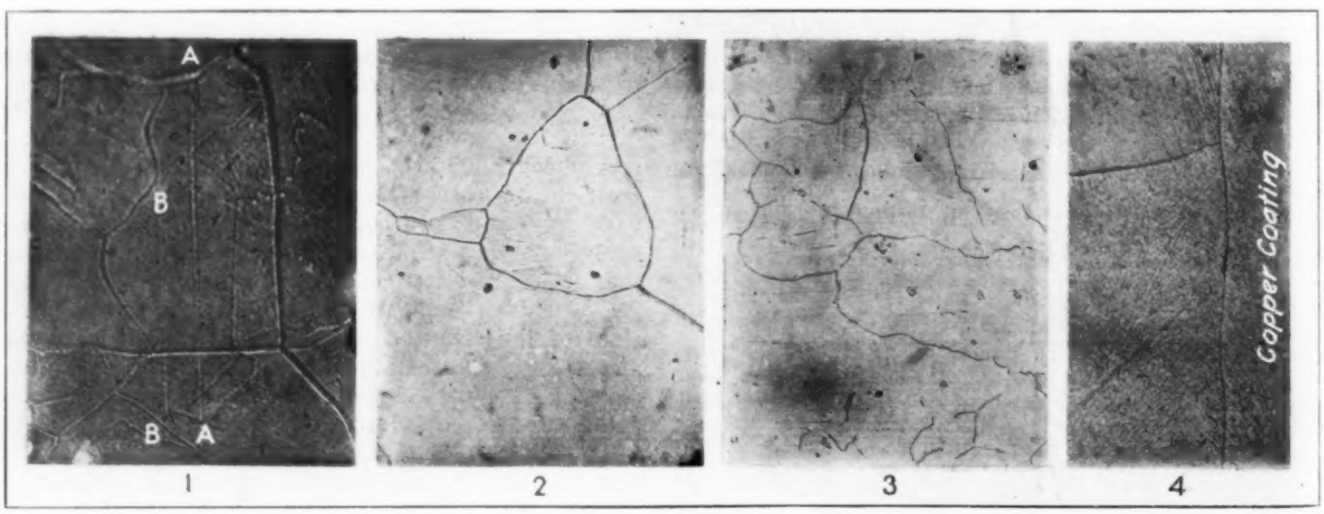
A synthetic low-carbon steel[11] having the following composition was selected as representative of this class of material: carbon, 0.18 per cent; silicon, 0.007 per cent. It had the following thermal characteristics: Ac_1, 738 deg.; Ac_2, 769 deg.; Ac_3, 840 deg; Ar_3, 792 deg.; Ar_2, 769 deg.; Ar_1, 700 deg. C. The specimens, first polished for microscopic examination, were heated in vacuo in the same manner as the pure iron, to the following temperatures, and were held approximately 30 min, at the maximum temperature: 950 deg. C., above Ac_3; 760 deg. C., above Ac_1; 700 deg. C., below Ac_1.

The slight roughening of the surface, due to the slipping, still persists at this temperature and shows that no marked volatilization has occurred at the surface. Even at this temperature the heat-relief has been sufficient to indicate clearly the islands of pearlite.

Fig. 5 is a specimen which, after polishing, was distorted enough to develop slip bands and then heated to 700 deg. C., just below the transformation Ac_1.

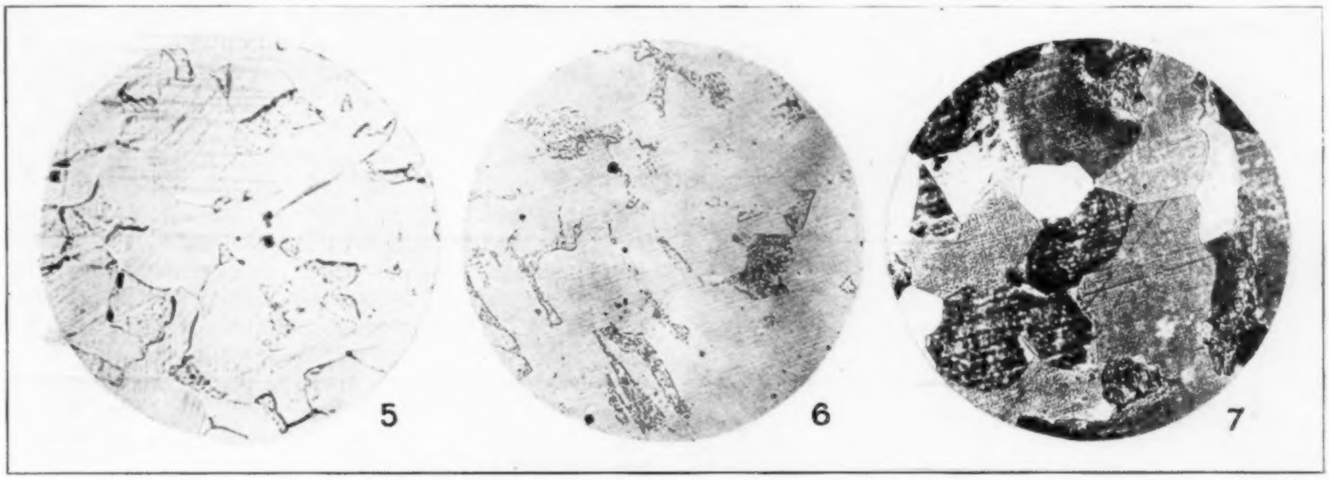
Fig. 6 shows the specimen of Fig. 5 after it had been

[11]An alloy of iron and carbon prepared according to the method given by U. S. Bureau of Standards. *Sci. Paper* 266.



FIGS. 1 TO 4

Fig. 1. Microstructure of pure iron above the Ac_3 transformation. Polished surface heated for 30 min. at 950 deg. C. Heat-etched. × 300. Fig. 2. Microstructure of pure iron between A_2 and A_3 transformations. Polished surface heated for 30 min. at 880 deg. C. Heat-etched. × 300. Fig. 3. Microstructure of pure iron just below the transformation temperatures. Polished surface heated for 30 min. at 700 deg. C. Heat-etched. × 300. Fig. 4. Undulating surface of heat-etched iron. Fig. 1 electroplated, cross-cut, polished and etched with 2 per cent nitric acid in alcohol. × 300.



FIGS. 5 TO 7. SOFT STEEL JUST BELOW Ac_1

Fig. 5. Polished specimen slightly distorted and heat-etched 30 min. at 700 deg. C. × 100.

Fig. 6. Fig. 5, slightly polished and etched with 2 per cent HNO_3 in alcohol. × 100.

Fig. 7. Unstrained steel, polished, heat-etched 30 min. at 700 deg. C., and then etched with HNO_3. × 100

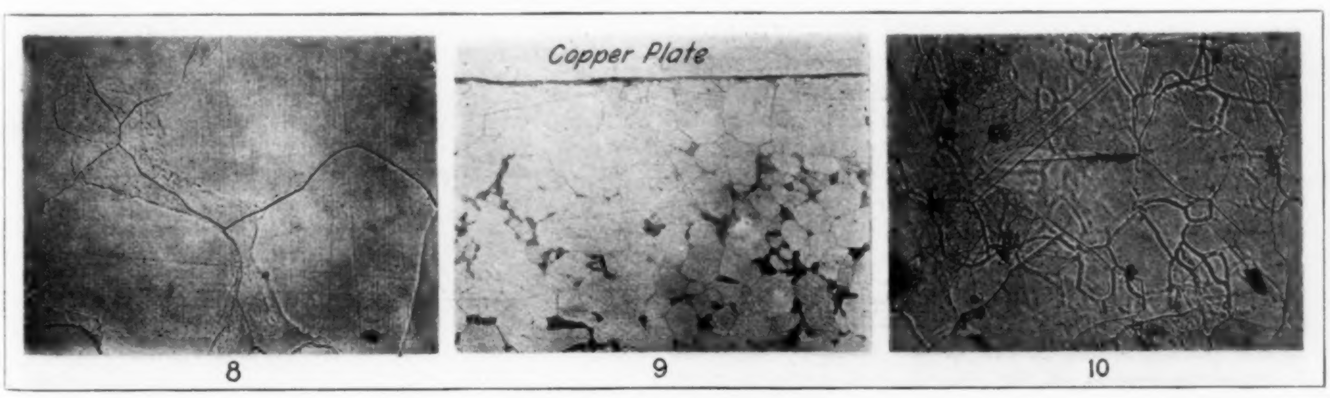
polished slightly to remove the effects of the heat-relief and then etched; it has the usual appearance of low-carbon steel. When the specimen is etched directly after heating, without any supplementary polishing, the surface darkens almost immediately and gives the appearance shown in Fig. 7. A similar pronounced darkening of ferrite, upon etching, is often observed when a specimen is finished on a polishing wheel which has been allowed to become dry, so that the surface heats considerably.

Upon heating a polished specimen of this synthetic steel above the Ac_1 transformation, the surface takes on the appearance shown in Fig. 8, which is very similar to that produced by heating below Ac_1; the position of the pre-existing pearlite islands is clearly indicated. It will be noted that the network which marks the boundaries of the ferrite crystals is now continuous *through* the pearlite areas instead of around them. When the surface is etched, without any polishing, the appearance is the same as is shown in Fig. 7. However, when the surface is slightly polished and then etched, no darkening results nor is there left any trace of the pattern developed by heat-relief. The material constituting the surface is pure ferrite; all the pearlite has been removed to a considerable depth, as is shown in Fig. 9, a section of the specimen perpendicular to the polished face, the normal appearance of the material being seen in the lower portion of the micrograph. The boundary between the outer, or carbonless, metal and the inner normal material is clearly defined, showing that the change from the outer zone to the unchanged metal of the interior is very abrupt.

If such a specimen as shown in Fig. 9 is heated for 30 min. at 950 deg. C., that is, above the Ac_3 transformation, a more clearly defined network, corresponding to the γ condition, is superimposed upon a less distinct one which shows the characteristic outlines of the α crystals. This is plainly seen in Fig. 10. The polished specimen in this instance was etched to reveal its initial structure and then heated for 30 min. at 1,000 deg. C., or well above the temperature of the Ac_3 change. The roughening of the surface, corresponding to the islands of pearlite shown by the initial etching, still persists. Upon this pattern two others are superimposed, showing respectively the crystalline condition above Ac_3 on heating, and below Ac_3 on cooling. The twin crystal which had its origin when the steel was in the γ state is seen to cut through the pre-existing islands of pearlite and to bear no relation to them. It should be borne in mind, however, that the carbide has been removed from the surface material, probably before the change to the γ state was brought about, as has been described above.

Nature and Extent of the Surface Changes Upon Heating

The magnitude of the change (apparently decarburization) which occurs in some samples (Fig. 9) makes the explanation offered by Howe mentioned at the outset



FIGS. 8 TO 10. SOFT STEEL ABOVE Ac_1

Fig. 8. Polished specimen heat-etched 30 min. at 760 deg. C. × 300.

Fig. 9. Fig. 8, electroplated, cross-cut, polished and etched with 2 per cent HNO_3 in alcohol. × 60.

Fig. 10. Fig. 9, heat-etched 30 min. at 950 deg. C. × 300.

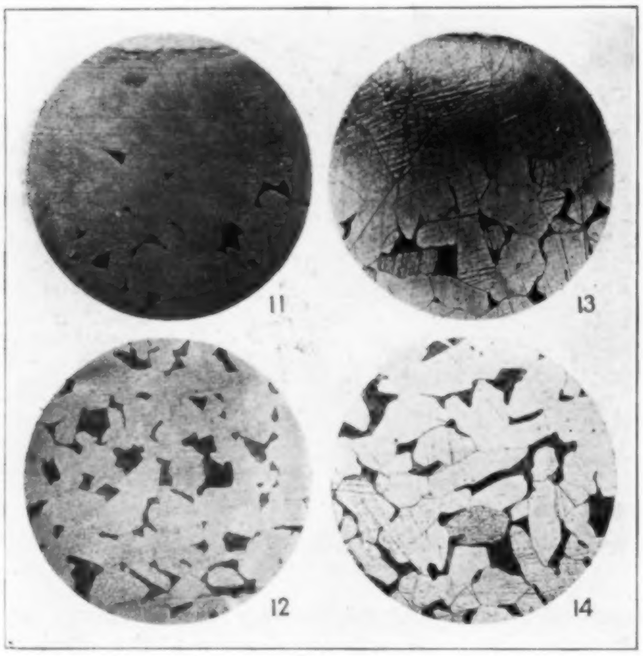


Fig. 11. Surface changes in soft steel produced by 4 hr. at 990 deg. C. Electroplated, cross-cut, polished and etched with 2 per cent HNO_3 in alcohol. × 250. Fig. 12. Structure of Fig. 11 at center of specimen. Fig. 13. Same as Fig. 11, but after four reheatings to 950 deg. C. for thermal analysis. Fig. 14. Structure of Fig. 13 at center of specimen.

appear inadequate. In order to show clearly the nature of the change, and to test his explanation, a series of specimens of the low-carbon steel previously used were heated for 30 min. in vacuo at the following temperatures: 760 deg. C., above Ac_1; 820 deg. C., just below Ac_3; 890 deg. C., above Ac_3. The specimens were cooled in the furnace at the same rate as the previous ones. In each case the carbonless layer varies considerably in thickness on the same specimen. In the specimen heated at the lowest temperature, the decarburized layer is more pronounced than in those heated for the same period at higher temperatures. This is not to be attributed to a greater loss of carbon at the lower temperature, but rather to an increased rate of diffusion of carbide in iron at higher temperatures, by which any change at the surface, due to loss of carbon, is masked by a replenishment from the interior.

Fig. 11 shows the condition at the surface and Fig. 12 near the center of a specimen (low-carbon steel previously used) heated continuously for 4 hr. above Ac_3, 990 deg. C. being the maximum temperature. The structure of a sample of the same material, previously used for a series of four thermal curves, which had been held above the Ac_3 temperature for a total of 4 hr., is shown in Figs. 13 and 14. The thickness of the altered surface layer of the sample heated intermittently is somewhat greater than that of the specimen heated continuously for 4 hr. above the Ac_3 transformation temperature. The carbon content of the interior, however, as estimated from the structure, is slightly less in the specimen heated continuously than in the other one. This apparently contradictory behavior of the more strongly heated specimen is to be interpreted as further evidence of the part played by diffusion in masking the change which occurs at the surface. By comparing micrographs it was noted that a much more marked change is produced in the surface metal by a short period at the lower temperature (30 min. at 760 deg. C.) than by prolonged heating at a higher temperature (240 min. at 990 deg. C.). Whether this difference in the rate of diffusion is due entirely to temperature or partially to the allotropic condition of the iron, α or γ, can only be conjectured.

Fig. 15 shows the surface change induced in a high-carbon steel by heating four times in vacuo to a temperature above the Ac_3 transformation (950 deg. C.). The steel had the following composition: carbon, 1.28 per cent; manganese, 0.23; phosphorus, 0.017; sulphur, 0.017; silicon, 0.23 per cent. The cementite grain-envelopes do not extend entirely to the surface, as they did originally, but gradually diminish in thickness and disappear at some distance below the surface. In no case was an accumulation of cementite found, such as Howe's explanation would require. In a few areas a very thin layer of ferrite was found to have formed, as shown in Fig. 16. The conclusion is evidently warranted that the change of structure of the surface metal heated in vacuo represents loss of carbon.

Interpretation of Results

It may properly be asked, To what extent are the etching indications of steel at high temperature vitiated by changes of composition that occur in the surface metal upon heating? The results previously described show that no decarburization below the temperature of the A_1 transformation can be detected. This is due to the physical form in which the carbon exists; not until the carbon (as carbide) is in the state of a solid solution in the iron, i.e., above A_1, is there any appreciable change in the exposed surface metal. Below the A_1 transformation, the carbon occurs as a definite crystalline compound and the loss upon heating may be entirely neglected.

A very marked change, however, occurs upon heating a specimen just above the A_1 transformation, when the carbon passes from the form of crystalline cementite to a solution (of cementite) in the iron. In this form it quite readily volatilizes from the surface, so that a pronounced carbonless layer is soon formed in specimens (low-carbon steel) that are held for periods no greater than 30 min. at this temperature. The method of "heat-etching," however, serves to record the structure both before and after the change has taken place. The pronounced differential expansion of pearlite and ferrite at the A_1 transformation will account partially for this. The fact that at temperatures below A_1 the structure is clearly revealed by heat-etching, however, shows that this is not the sole cause, but that the slight general volatilization which occurs, together with the slight differences in the rate of thermal expansion of pearlitic

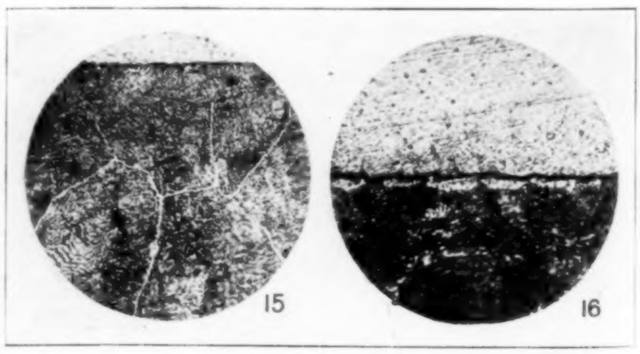


Fig. 15. Average surface condition of high-carbon steel after heating four times in vacuo to 950 deg. C. Electroplated, cross-cut, polished and etched with 2 per cent HNO_3 in alcohol. × 250.
Fig. 16. Exceptional surface condition of Fig. 15. Etched with hot sodium picrate, which turns cementite black. × 250.

steel and iron (ferrite) are sufficient to record clearly and definitely the structure of the metal. The volatilization of iron is sufficiently pronounced at the crystal boundaries to show them clearly, but across the face of the crystals there is very little loss, as is proved by the persistence of slip bands, upon heating. That the ferrite is changed somewhat is shown by its increased tendency toward oxidation. Upon slight etching with nitric acid, a distinct oxide film readily forms, coloring the ferrite very dark.

Specimens heated to temperatures higher than the A_1 transformation show a carbonless layer, which becomes thinner as the temperature is increased. This is properly to be attributed to the increased rate of diffusion of carbide in iron, by which the change at the surface is masked. The results obtained by etching specimens at the higher temperatures (heat-etching or otherwise) are more truly indicative, therefore, of the structure of the interior than those at lower temperatures, e.g., just above A_1. That the loss of iron by volatilization across the face of the crystals is very slight, even at high temperatures, is proved by the persistence of the slight roughening due to preliminary etching throughout the entire period of heating. The loss by volatilization is of a magnitude sufficient to show the crystalline structure by the production of "etching pits"; at the crystal boundaries the loss is much greater. In addition, the carbide is removed to an appreciable depth on all the exposed faces of the specimen.

SUMMARY

1. When polished metal specimens are heated in vacuo, a record of the structure existing at the particular temperature used is inscribed on the polished surface of the specimen. This record consists of a slight roughening due to volatilization and to a slight "buckling" of the surface, due to the volume change accompanying the transformation. The terms "heat-relief," "heat-etching" and "vacuum-etching" have been applied to this method of developing the microstructure.

2. By means of heat-relief the structure of iron and steel at high temperatures is readily revealed. This is a much simpler method than the high-temperature etching often used. It appears probable that much of the effect usually attributed to etching at high temperature is due to the heating itself.

3. An appreciable change of composition and structure of the surface metal occurs in steel, upon heating. This is strongly marked just above the A_1 transformation, and becomes less so upon heating to higher temperatures, due to the increased rate of diffusion of carbon (as carbide) in iron. The structure revealed on the surface by heat-relief, or by high-temperature etching, is less representative of the interior at temperatures just above the A_1 transformation than at any other temperatures.

4. The change in composition of the surface layer of steel heated to high temperatures in vacuo is to be explained as due to volatilization of the carbide. No appreciable change takes place until the carbide enters into solid solution, i.e., above the A_1 transformation.

5. The volatilization of iron from the surface, upon heating, is very slight. Polished specimens of iron and steel, etched before being heated, retain the slight roughening due to the etching, even after pronounced heating. The volatilization of iron at the crystal boundaries is more rapid than across the face of the crystal.

Development of the Italian Chemical Industry

Owing to its close territorial proximity to Germany and to the strong foothold that Germany had obtained in its economic life, Italy was largely dependent upon Germany for many chemical products prior to the war, its own chemical industry not having reached a high stage of development. Consequently, when the outbreak of the war interfered with its usual supply, a serious shortage of chemicals occurred, and as early as November, 1915, six months after Italy's entrance into the war, the Italian Minister of Industry, Commerce and Labor called a conference to discuss ways and means of overcoming this deficiency. In June, 1916, a permanent Committee for the Chemical Industry was appointed, which has been making a thorough study of the situation and compiling data regarding Italy's production, exportation, and importation of chemicals. From the first report of this committee, which has just been published, have been taken most of the figures which are given below. While in some instances these figures are only approximate, they indicate the progress which has been made by the Italian chemical industry and the degree to which Italy has been able to free itself from its former dependence upon foreign sources of supply.

The following table illustrates clearly the great strides made in Italy during the last few years:

Chemical Products	Average Monthly Production in 1914-15 Tons	Average Monthly Production in 1918 Tons
Fatty acids	285	520
Citric acid	75	150
Nitric acid	1,525	7,150
Concentrated ammonia liquors	....	1,484
Anilin and derivatives	....	110
Crude anthracene	15	38
Crude benzol	....	382
Pure benzol	9	358
Carbonate of lime	20	50
Carbonate of magnesium	14	92
Mineral tar	....	4,139
Vegetable tar	25	50
Chlorate of sodium	16	670
Liquid chlorine	15	75
Chloride of magnesium	3	20
Chloride of zinc	....	63
Mineral colors:		
Lead white	230	310
Zinc white	157	247
Minium	176	838
Ultramarine	....	13
Others	47	102
Total	610	1,510
Artificial organic colors:		
Sulphur colors	2	152
Other colors	2	13
Total	4	165
Tanning extracts	850	1,950
Sulphuric ether	56	315

Chemical Products	Average Monthly Production in 1914-15, Tons	Average Monthly Production in 1918, Tons
Phenol:		
Pure crystallized, synthetic phenol	....	408
Crude, for distillation of tar	5	25
Total	5	433
Crude phosphorus	....	50
Hyposulphite of sodium	20	100
Sublimated naphthalene	29	61
Nitrate of ammonia	....	655
Nitrate of lead	1	20
Nitrate of potassium	180	350
Oxide of aluminum	147	275
Wood pulp	100	650
Concentrated caustic soda	270	1,150
Caustic soda solution	660	2,360
Sulphate of ammonia	1,150	3,300
Sulphate of magnesium	87	125
Sulphate of copper	6,500	8,400
Anhydrous sulphate of sodium	1,150	1,460
Crystallized sulphate of sodium	770	900
Sulphite of sodium	2	30
Carbon disulphide	185	325
Acid tartrate of potassium (cream of tartar)	70	115
Carbon tetrachloride	10	74
Toluol	....	110
Xylol	....	18

The Gutta-Percha Industry

GUTTA-PERCHA is a jungle product, obtained from trees growing wild in tropical forests. Borneo, particularly Sarawak, supplies the largest quantities, although Sumatra and the Federated Malay States furnish a certain amount. Some efforts have been made to cultivate the gutta-percha tree on estates, but they do not appear to have been successful, which is due to the fact that the tree can thrive only in certain localities possessing the requisite humidity or rainfall and good drainage such as afforded by foothills, and these conditions occur very seldom outside of certain jungle areas. So far as can be learned there is only one district in Sarawak where gutta-percha trees have been cultivated with any success. This plantation has now been in existence about thirty years and is only just beginning to yield supplies in marketable quantities. In this connection it may be stated that about twenty years are required before the trees are in a fair way to produce. If trees are tapped earlier, the production is small and a great risk is run of the trees withering and dying before fully matured. This fact in itself would discourage the investment of any large capital in the industry, to say nothing of the extreme difficulty in successfully cultivating the trees outside of their native jungles.

Methods of Collection—Increase in Production

The milk of the gutta-percha is obtained by tapping, but in many cases the trees are cut down in order to obtain larger quantities. While this process does not actually destroy the life of the tree, inasmuch as new shoots will in time spring from the stump, it effectually cuts off the source of supply for many years. For this reason the felling of gutta-percha trees has, it is understood, been prohibited in Sarawak.

The latex is collected by natives, brought down to various villages, and bartered to the Chinese for rice, tapioca, salt, etc. At the present time, owing to the high cost of rice, the natives must collect considerably more than in former years in order to secure needed supplies of this staple article of diet.

The production of gutta-percha in the various districts in this section is estimated to have been between 450 and 500 long tons in 1918, while in 1919 it was between 600 and 700 tons. The production is regulated according to existing values, and, should prices advance, it is to be anticipated that for 1920 it will amount to 800 or 900 tons. It is known that the production of gutta-percha is stimulated by further special inducements being made to the natives, who are the actual collectors. Without such inducements it is not probable that any appreciable increase in the present output of the commodity will be effected.

Prices, and Factors Influencing Prices

As an example of the upward tendency in the prices asked for gutta-percha, it may be stated that "Pahang Red," which five years ago cost approximately \$158 per picul (133⅓ lb.), rose to \$312 at the close of 1919, with supplies even at this price practically unobtainable. Similarly, "Banjirmassin" increased from \$85 to \$142 during the same period, and this may be taken as a fair average of the advances made on all grades of gutta-percha during the past five years. It will thus be seen that increases of 80 to 100 per cent have taken place.

The local, as well as neighboring, press has recently published articles to the effect that projects were on foot looking to the construction of Pacific cables, in one instance from the United States to the Philippine Islands, and in another from the United States to Japan. Neither report has as yet been confirmed, but it is not unlikely that even rumors of this nature will have a tendency to stiffen the market, not only in view of the considerable quantities of gutta-percha that such an undertaking would require, but as a result of the keen competition that would set in.

Another point to be carefully borne in mind with regard to the production and cost of gutta-percha is the constantly increasing area of land under rubber, cocoanut, and tapioca cultivation. These new estates are well regulated and offer every inducement to the coolie type in the way of compensation and better standards of living. This class of work will, therefore, undoubtedly attract the native and coolie labor away from the jungle, and the clearing of so many tracts of land may mean the diminution of jungle areas and a consequent decrease in jungle products.

Imports and Exports at Singapore

Gutta-percha to the amount of 1,469 long tons, valued at \$1,468,792, was imported into Singapore during the year 1918. Of this amount 1,372 tons, at a value of \$1,358,764, were imported from the Dutch East Indies, while only 91 tons, valued at \$107,431, were imported from British North Borneo, Sarawak, and the Federated Malay States.

Of gutta inferior, 5,243 tons, valued at \$518,975, were imported into Singapore during the year 1918, most of which came from Dutch Borneo and Sarawak, Sumatra furnishing only 300 tons.

The following table shows the quantities, values, and countries of destination of gutta-percha and gutta inferior exported from Singapore during 1918:

Gutta-Percha

Countries of destination	Quantity Tons	Value
United Kingdom	1,596	\$1,556,357
Canada	138	44,895
France	113	43,909
Italy	30	11,447
Japan	33	22,755
United States	1,230	362,736
Total	3,140	\$2,042,099

Gutta Inferior

Countries of destination	Quantity Tons	Value
United Kingdom	99	9,539
Canada	71	6,365
Australia	17	1,797
Other British possessions	1	42
France	10	1,022
Japan	144	16,009
United States	834	89,959
Other foreign countries	2	227
Total	1,178	124,960

Copper Production in Sweden

The Swedish Government Board of Trade states that the production of copper in that country during 1918 amounted to 3,261 tons. Of this amount 4,740,651 lb. was of refined copper, made from "cement copper," valued at 14,542,340 crowns (\$3,898,750 at normal rate of exchange); 1,769,570 lb. refined copper made from "bessemer copper," valued at 6,057,258 crowns (\$1,626,610); and 12,969 lb. electrolytic copper, valued at 39,957 crowns (\$10,712). These values are what may be called factory prices. The production of individual mines cannot for the present be stated.

A New Type of Catalyzer for Hydrogenation*

A Description of a Method of Preparing Finely Divided Nickel Catalyzer by Mechanical Grinding—Scientific Aspects of Abraded Nickel Catalyst—Water-Ground Material Superior

BY W. D. RICHARDSON

THIS paper contains a description of mechanically prepared catalyzer for the hydrogenation of oils and for other processes in which metallic catalyzers are used, invented by Benjamin W. Elder, developed by W. B. Allbright of the Allbright-Nell Co., Chicago, and put on a practical operating basis in the writer's laboratory.

This catalyzer differs fundamentally in its method of preparation from catalyzers previously used and is not only of importance in a practical way but is of perhaps even greater scientific importance as a contribution to the theory of catalyzer activity. The process and product are covered by the Elder patents, assigned to the Allbright-Nell Co. of Chicago, Nos. 1,331,903, 1,331,904, 1,331,905 and 1,331,906 of Feb. 24, 1920, and by pending applications.

In March, 1917, there appeared at the laboratory of Swift & Co. a short, stocky, bronze-complexioned man of middle age who was introduced by W. B. Allbright, his companion, as Benjamin W. Elder, recently of Torreon, Mexico. This meeting was the result of previously made arrangements according to which Mr. Elder's process was to be further developed and worked on a practical commercial scale.

Mr. Elder brought with him the simple and primitive appliance which was one of those by which he first proved that an effective and active nickel catalyzer for the hydrogenation of oil could be made by the action of an abrasive upon bulk nickel.

INITIAL WORK ON GRINDING NICKEL

This apparatus consisted of a nickel plate about 12 in. square and $\frac{1}{16}$ in. thick, firmly fixed by screws placed at the corners to a wood block of the same dimensions and $\frac{3}{4}$ in. thick. The other member of his apparatus consisted of a metal sheet or plate measuring about 2 x $2\frac{1}{2}$ x $\frac{1}{8}$ in. and screwed to a wooden handle. In order to operate with this apparatus Mr. Elder coated the plate with an oil, such as cottonseed oil, placed thereon a sufficient amount of abrasive, such for example as 200-mesh ground sand or silica, and then, by a process of rubbing the small plate upon the large one with the oil and abrasive between, produced in time finely divided, mechanically prepared, metallic nickel, which upon trial proved to be an active and effective catalyzer for the hydrogenation of oils.

This was not actually the very first apparatus used by Mr. Elder. An earlier one is described in a letter to the writer dated at Los Angeles, April 6, which reads in part as follows:

> It was the unpleasant and dangerous experiences that I had encountered in reducing catalyzers that first made me think of trying to produce "nickel in a finely divided state" mechanically.
>
> Observing closely the oil from a journal bearing encouraged me to give more thought to the subject. I noted that the abraded metal in the waste oil was so fine that it was difficult to thoroughly remove it from my hands.
>
> I finally concluded that what I would really have to do was to design some method of grinding the nickel in the oil that I intended to harden while the oil was hot in a tank that was supplied with hydrogen. I was living in Torreon at that time and Villa was making things so hot that I concluded to get out if possible to the States, but I only got as far as Monterey, where I met a student at one of the colleges, who offered to get me a piece of sheet nickel from the college laboratory.
>
> I finally completed my apparatus, which consisted of a small tank that could be heated externally. In the bottom of the tank I fastened the piece of sheet nickel. Resting on the nickel was a carpenter's oilstone which could be turned by a shaft that passed through the top of the tank. There were the necessary valves for oil and hydrogen, etc. With this crude apparatus I made four or five trials, using about 3 gal. of cottonseed oil before I got things in shape and the apparatus tight. The last trial I made with this apparatus, I think, I had a peon turning the crank that actuated the stone and watching the temperature, while another was attending the gas producer. I think I kept this going three days, as the oil was getting darker each day from the fine nickel that was present, and when the sample of the third day cooked down I was sure that the oil had apparently hardened somewhat.
>
> The next day Carranza attacked the town and my little laboratory was burned down, but several days later I removed some of the wreckage and secured some of the oil from the tank, and then I knew for sure that I had done some work.
>
> Shortly afterward I returned to the States, and it was while I was working for the Allbright-Nell Co. that I mentioned to W. B. Allbright my experiences in trying to produce a nickel catalyzer mechanically. Mr. Allbright offered to finance me if I would continue the line of investigation and I accepted his very kind offer.
>
> After several months trying all kinds of abrasives, I suddenly remembered the black oil from the journal box, and it was not long before I was grinding a mixture of oil and finely ground quartz. After several trials I was sure I was on the right track. I next secured a sheet of nickel about 12 in. square and with a piece of old anode for a rubber or scrubber I was able to produce a catalyzer that would harden cottonseed oil in five or six hours.
>
> During all this time I was greatly encouraged by the cheerfulness of Mr. Allbright, and many very interesting experiments that he suggested were carried out. I think he suggested to me to use an ordinary closed tumbler or tube mill filled with grain nickel, oil and finely ground quartz. In the tumbler we tried out an atmosphere of hydrogen, also carbon dioxide.
>
> There were some features about the catalyzer that we did not fully understand, and at this stage of the game we applied to W. D. Richardson, chief chemist of Swift & Co., to assist in putting on the finishing touches and rounding off the corners that had troubled us so sorely towards the end.
>
> The time I spent with Mr. Richardson and his assistants satisfied me that they were as enthusiastic as Mr. Allbright and myself regarding the possibilities of a mechanically produced catalyzer, and especially was I satisfied that what I had set out to do had been accomplished.

At this point I should like to make a few observations in retrospect upon the Elder process. In the first

*A paper read at the St. Louis meeting of the American Chemical Society, April, 1920, Division of Industrial Chemists and Chemical Engineers, and published by permission of the Society.

place, you will notice that Mr. Elder had the courage of his convictions, which the great majority of chemists have not. We have been talking for years about finely divided nickel and other metals as catalysts, but no one before Mr. Elder had the sagacity and courage to prepare finely divided nickel by the simplest and most practical means. In short, we have all talked about finely divided nickel and finely divided metals as catalysts, but did not produce catalysts in the way suggested by our words, namely, by taking bulk metal and subjecting it to a process which would actually finely divide it in the precise meaning of those words. On the contrary, our so-called finely divided catalyzers have been produced in the past by a reduction in a chemical way of metallic salts, oxides and other compounds.

As a second observation, it appears after Mr. Elder's invention that whenever anyone of us took the trouble to whet his pocket-knife upon an oilstone he produced catalytic material, in this case catalytic iron, and furthermore, that all used lubricating oils which have been used to lubricate the surfaces of iron and more noble metals contain after a period of time finely divided catalytic material, although probably in most cases contaminated by carbon, sulphur and other substances sufficient to reduce the catalytic activity by a considerable amount.

Mr. Elder used the catalytic nickel prepared by him with the simple apparatus I have described to hydrogenize cottonseed oil in a laboratory way. The catalytic material produced in this small apparatus consisted naturally of a suspension of the finely divided metallic catalyst in oil, together with a certain amount of the abrasive. The longer the rubbing or abrading process was continued, the greater would be the relative portion of metal contained in the suspension. If the abrasive action was continued for a short time only, then the abrasive would predominate in the mixture. Mr. Elder also prepared catalyzer in dry form by abrading nickel surfaces with a suitable dry abrasive in the absence of oil. This catalyzer was found to be active, but not as active as catalyzer prepared in oil.

Grinding With Counter Rotating Disks

Naturally the amount of catalyst which could be produced by man power applied to Mr. Elder's first apparatus within a reasonable length of time was very small, and hence Mr. Elder approached Mr. Allbright with the view of making arrangements for working upon a larger scale. With this end in view an apparatus was made consisting of two disks of nickel made to rotate in opposite directions by mechanical means and to the opposed surfaces of which hot oil could be supplied. The friction of one plate upon the other caused finely divided nickel to be rubbed off into the oil and thus catalytic material was produced, but the amount was too small within a reasonable length of time to make this method of production a practical one.

Tube Mill With Nickel Shot

As a further step a cast-iron tumbling mill was then made in which nickel shot was placed, together with a suitable abrasive and oil, and the entire mill rotated until a sufficient amount of catalytic material was obtained. This cast-iron mill was of a special shape designed to give maximum abrasion. It measured about 3 ft. in diameter and was 2 ft. long, measured along the shaft. It was soon found that the cast-iron mill did not produce the most desirable catalyzer for the reason that the abrasive acted not only upon the nickel shot contained in the mill but upon the sides and surfaces of the mill itself to such an extent that the final catalyzer obtained might contain as much as 60 parts of cast iron and carbon derived therefrom to 40 parts of nickel. This was the extent of the development of Mr. Elder's process as carried on by W. B. Allbright working with Mr. Elder in the plant of the Allbright-Nell Co., Chicago. The process was then turned over to the writer for further development in the Swift & Co. laboratories and plant.

After preliminary trials in the laboratory with small porcelain pebble mills, larger tumbling or pebble mills of the Abbé type were installed and these, in order to avoid contamination by iron admixture, were lined with porcelain brick. These mills measured about 5 ft. in diameter by 5 ft. long and were capable of holding a considerable charge of nickel shot.

Several Types of Abrasives Tried

In the laboratory and also in the larger mills all sorts of abrasives were tried—ground quartz of various mesh, ground pumice, carborundum, alundum, diatomaceous earth, etc. It was even found that a first-class catalyzer could be obtained with no abrasive at all, the friction of nickel shot on nickel finally resulting in the production of excellent catalytic material. During the course of the tumbling it was to be expected that a certain amount of the porcelain lining would become abraded and mixed with the catalytic material and abrasive. This admixture was not harmful to the catalytic activity of the finely divided metal, but from time to time the mills had to be relined. No attempt was made to separate the catalytic metal from the admixed abrasive. Many batches of oil were hydrogenized with the catalytic material just as it was removed from the mills and no adverse results were experienced from the presence of the abrasive or abraded mill lining. Mechanical catalyzer was prepared by the Elder process both in the presence of air and of hydrogen and no great practical difference in activity in the two cases resulted.

Since a semi-drying oil was generally used in the mill, any atmospheric oxygen in the mill was usually absorbed by the oil during the course of the run, so that by far the greater portion of the catalytic material was actually prepared in the presence of nitrogen only, in this case. One other method of preparation, namely, by grinding in the presence of water instead of in the presence of oil, was made use of, and this produced a more active catalyzer, as will be described further on after a consideration of the original Elder catalyzer ground in oil.

A Nickel Mill

An ideal mill for the preparation of metallic catalyzer by abrasion would be constructed with a lining of the same kind of metal as the charge and the desired catalyzer. For the preparation of nickel catalyzer, the lining of the mill would consist of nickel plates, preferably of sufficient thickness so that they could be wedged into place against the circular periphery of the mill. The side plates would have to be screwed or bolted on, and if thinner plates were used, these plates would naturally have to be screwed or bolted to the casing at all surfaces. Such a mill would undoubtedly produce a very much larger yield of active catalyzer than a

porcelain-lined mill and would have the further advantage of avoiding additional contamination of silica or silicates from the lining. Although this contamination does not injuriously affect the catalyzer, it necessarily does dilute it beyond the dilution which would be determined by the introduced abrasive alone. The metallic linings would have to be replaced from time to time when they were worn too thin, but there would be no loss of nickel, since the removed plates could be cut into small cubes or melted into shot and reintroduced as a part of the charge.

The Elder Nickel Catalyzer

Under the microscope the Elder catalyzer is seen to consist of minute, opaque metallic particles usually but not invariably characterized by straight line edges and sharp angles. They are of various sizes, depending on the abrasive used and the length of time used in their preparation. Often they appear to be in the form of thin plates and some of them remain unattached, while others clump themselves into groups or lines. The particles have a distinctly metallic appearance as contrasted with the translucent or transparent appearance of some chemically-prepared catalyzers of extremely high activity.

In activity the Elder catalyzer ranks very high, and this apparently can be increased indefinitely by long-continued abrasion. It is obvious, however, that there is a practical time limit to the operation and under ordinary operating conditions this cannot with economy be exceeded. It varies according to the type of mill used, the abrasive used, the amount of oil used, etc. It can be made to approach very closely to chemical catalyzer of the highest activity, although it is probable that chemical methods produce somewhat more active catalyzer under practical working conditions than that capable of being produced mechanically. However, it is very much superior to slow-acting chemically prepared metallic catalyzer and to much of the catalyzer that has been used in the past regularly for hydrogenation as well as for other purposes.

Action of Mechanically Prepared Nickel Catalyzer

The action of mechanically prepared nickel catalyzer in the hydrogenation of oils is somewhat different from that of other catalyzers of the same activity. The chemically prepared catalyzers for the most part when introduced into an oil in the presence of hydrogen show almost their highest activity at the start, that is, they may increase in activity by a small amount only, before the activity curve begins to fall. As contrasted with this form of curve, the Elder catalyzer activity curve shows a considerable rise at the commencement of hydrogenation which may last for some time before the curve reaches its peak and begins to decline.

The catalyzer can be used over and over a number of times like other active catalyzer. The usual method of recovery for re-use is by means of filter pressing. In the case of highly refined edible oils, the catalyzer may be recovered and used again for from five to ten or even twenty runs; in the case of lower grade oils, the catalyzer is killed after a much shorter period of use in the same manner as other metallic catalyzers and doubtless by the same means. There always seems to be a noticeable amount of combined sulphur present in dead catalyzers, and without doubt sulphur is one of the active poisoning agents.

The final recovery of the nickel catalyzer made by the Elder process is by means of fusion in a small oil- or gas-fired furnace. The filter pressed catalyzer with its attendant abrasive is first freed of fat by extraction or by burning, then mixed with a suitable flux and introduced into the furnace. The nickel becomes molten and can be recovered in the form of shot by running into water in the usual manner.

The fact that the abraded portions of the bulk nickel or nickel shot consist of catalytic material naturally suggests as a corollary that the abraded surfaces of the nickel shot or bulk nickel itself are also catalytic, and this is the fact. The shot, therefore, after abrasion could be used for hydrogenation in a hydrogenation tower and could be reactivated by the very simple process of removal from the tower and introduction into the abrasion mill.

Simultaneous Grinding and Hydrogenating

Mr. Elder, in one of his patents, describes another ingenious application of his process. He maintains the catalytic material in a state of continued activity by conducting the hydrogenation process in the abrasion mill itself. Under such circumstances a continuous supply of active catalytic material is afforded and the activity of the catlyzer therefore cannot run down. The rate of chemical action is limited only according to the law of mass action and not by the poisoning of the catalyzer. I do not mean to suggest by this that poisoning does not occur, but only that it is not effective, inasmuch as a fresh supply of active catalytic material is continuously furnished.

Scientific Aspects of Abraded Nickel Catalyst

The type of catalyzer which I have described is not only of the greatest interest and importance in a practical way for the hydrogenation of oils and for other industrial catalytic reactions, but may be considered perhaps even more important for the theory of catalysis. That theory, particularly wherein it deals with metallic catalyzers, has emphasized the fact that the catalytic action was a surface action and presumably proportionally to the total surface of the catalytic metal or metal particles. Nevertheless, in the past metallic catalysts have been made universally by chemical means and while it was known that when working by reduction processes metallic catalysts in a very fine state of subdivision were obtained, the extent of the surface was to a large degree beyond control and it would have been difficult working by chemical means to obtain catalysts consisting of graded particles of different sizes and with different ratios of surface to mass. By the abrasion method catalysts of every degree of activity can readily be obtained from coarse, slowly acting catalysts to those of the utmost fineness, surface extension and activity.

Another point of the greatest interest is the fact that when the abrasion method is used there can be no doubt about the metallic character of the product. In the case of nickel catalyzer designed for hydrogenation and prepared by the chemical methods, it has been claimed by one school of theorists that the active particles do not consists of metallic nickel but of a suboxide of nickel and that in the true metallic condition finely divided nickel is unsuited for the purpose of hydrogenation.

The abrasion method for preparing nickel catalyst

proves beyond question that finely divided metallic nickel obtained from bulk nickel by purely mechanical means is an active catalyst for the hydrogenation of oils and other hydrogenation reactions. The nickel particles so prepared (as described above) are decidedly opaque and metallic in appearance under the microscope. They also become decidedly magnetic when placed in a magnetic field and thereafter tend to group themselves end to end in chains as might be expected, while, under the influence of a bar or horseshoe magnet, the particles group themselves along the Faraday lines of force as do iron filings.

Effect of Temperature on the Activity of Metallic Catalyzer

The statement has been made and reiterated in the chemical literature that nickel catalyst must be prepared at a low temperature to be active, the temperature favored for the reduction of nickel oxide, for example, being about 300 deg. C. and preferably lower if effective reduction conditions can be maintained at a lower temperature. The facts in the case of chemically prepared reduced catalyzer are well established. If high temperatures are used for the production of such catalyzer, an inactive product is obtained, but the underlying assumption that heat treatment in and of itself must of necessity produce an inactive catalyst appears unwarranted in the light shed by Mr. Elder's discovery. The nickel shot or the nickel plates used for the production of this catalyst have been subjected to a temperature above the melting point of nickel, let us say above 1,470 deg. C. All of the catalyzer particles have been heated to this temperature, but it has not had the effect of deadening their activity. Our views, therefore, in regard to the effect of high temperatures on metallic catalyzers will have to be modified in conformity with these new facts established by mechanically prepared metallic catalysts.

Water-Ground Catalyst More Effective

I should like to conclude my paper at this point, having shown definitely and conclusively that nickel catalyzer prepared by the abrasion process and in the metallic condition and having been subjected to a high temperature is a decidedly active catalyst, but as a matter of fact, working in our laboratory and plant on the development of mechanically prepared catalysts, we were able to produce a still more effective catalyst by substituting water in the abrasion mill for oil. Catalyzer prepared in the presence of water has the disadvantage of necessitating the removal of the water and the substitution of oil therefor prior to the introduction of the catalyst into the hydrogenation apparatus or converter. This, however, was not especially difficult or expensive. The catalyzer produced in the presence of water was definitely, decidedly and invariably more active than that prepared by grinding in oil. Various explanations for this increased activity may be assumed:

1. That in the presence of water the abrading action produced a more finely divided catalyst.

2. That there would not likely be any catalyzer poisons in the water which might on the other hand be present in any oil produced.

3. That by grinding in water and in the presence of air a film of sub-oxide is formed on the catalyzer particles.

The last explanation may be the true one[1] and if so we are once more confronted with the importance of the sub-oxide theory and forced to conclude (if this explanation is correct) that while nickel in the metallic condition will catalyze hydrogenation reactions, nickel coated with a sub-oxide layer will catalyze at a still more active rate. However, a comparison should be made at this point between mechanical catalyzer prepared in water and by dry abrasive in air with no fluid medium present. In the last-mentioned case an active catalyzer was produced, but one much less active than the two other types mentioned. Apparently, therefore, too much oxidation during preparation is injurious, and if a sub-oxide film increases the activity of nickel catalyzer, this film must be kept within the narrowest limits if the most active type of catalyst is desired.

Sub-Oxide Theory

In considering the sub-oxide or oxygen-layer theory, it should be remembered and emphasized that we are dealing with a hyrogen reaction and that to bring this reaction about, the catalyst, whether nickel or palladium or other metal, must have, or does have, large volumes of hydrogen occluded on its surface and below the surface. It is difficult to believe that any oxygen or oxide could long persist under this condition and at the relatively high temperature employed in hydrogenation, but on the other hand, the reduction of the oxide or oxygen-layer might result in an increase of surface by roughening or furrowing, and if this hypothesis is correct, metallic nickel would still be the active agent, a larger surface having been obtained by alternate oxidation and reduction. Again, the oxygen might have the effect of offsetting the influence of certain poisons such as sulphur (sulphides), which when exposed would not again be reduced under the conditions of the reaction, as is well known. Sulphates, such as calcium sulphate, sodium sulphate, nickel sulphate, etc., have been found to be quite without adverse effect or any effect at all in the hydrogenation of oils.

Conclusion

In this paper I have not attempted to give a complete exposition of the preparation of metallic catalyzers by mechanical means, but only to touch upon the more important points. They are comparatively new in industry and have not as yet had the widest use. They must commend themselves for the simplicity, certainty and directness of their preparation and for their necessary uniformity. They will undoubtedly prove useful in developing the theory of catalytic activity.

In conclusion, acknowledgment is made to Paul Escher and G. W. Phelps of the Swift & Co. laboratory force for assistance in developing the catalyzer.

Laboratory of Swift & Co.,
Chicago, Ill.

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A series of films will be shown this year in eighty-six of the principal cities of western Europe, America and the British colonies, which, experts consider, will be a fine advertisement.

[1]In this connection compare Rupert: "The Effect of Surface Oxidation on Some Metallic Catalysts," *J. Am. Chem. Soc.*, vol. 42, p. 402, March, 1920. References to the previous literature are given.

Volatilization in Assaying*

Losses Often Ascribed to Volatilization Caused by Excessive Temperatures Are Usually Due to Dusting and Other Mechanical Causes—A Review of the Literature Published on Losses Due to Volatilization for Gold, Silver, Lead

BY FREDERIC P. DEWEY†

IT IS common to blame irregular assay results upon volatilization, and much has been written upon the subject, but there is no real evidence that in a properly conducted assay, the loss of either gold or silver by volatilization is sufficient to affect appreciably the result, even when arsenic or antimony may be present. Bulk assays of flue dust from assay muffles have been published, but the data given are totally insufficient to even approximate the volatilization from a single assay; and such figures as we have indicate the volatilization to be extremely small. Diligent search in the literature and wide inquiry among assayers and instructors have failed to produce a single case where the litharge volatilized in making an assay has been collected and assayed for gold and silver. Having attempted to do this, with most indifferent success, I am not surprised that this has not been done.

While various textbooks give volatilization as a cause of loss in cupellation, it may safely be said that in the rare cases where the volatilization is sufficient to affect appreciably the result it is due to excessive temperature. Percy[1] says, "The loss of silver by volatilization during cupellation is very slight (unless the temperature has been much too high), and may be disregarded." This statement is repeated by the Beringers[2] and Smith,[3] who include gold and silver. Mitchell[4] says that litharge fume rarely contains over one ten-thousandth of silver. Campredon[5] says that at a proper temperature no silver is lost by volatilization.

Primarily, excessive temperatures may be due to too high general temperature in the muffle; but it may often be due to temperature localized within the bead by oxidation of the metals, and this may be influenced by other causes than the general temperature. I have shown an extreme case of local temperature,[6] resulting in the burning of zinc with its characteristic flame and variations in bead temperatures with uniform pyrometer readings. Volatilization from a bath of mixed metals is not the simple question of vapor pressures of the contained metals. Based entirely upon vapor pressures, Richards,[7] in speaking of the distillation of zinc from Parkes crust, says, "Successively larger amounts of lead, silver and gold come over the higher the temperatures," but I have shown[8] that more silver goes with the zinc in the early stages of the operation than later.

The possible volatilization of the precious metals in cupelling is the most complex proposition. It may be due to the vapor pressure of the individual metals, the vapor pressure of alloys or possible metallic compounds, of compounds of metals with metalloids or with non-metals, particularly oxygen. Also it is not possible to draw a sharp line between true volatilization due to vapor pressure and the drag of a volatilizing body exerted upon a less volatile associate, against which is the counter-drag, or stabilizing effect, of the non-volatile upon the more volatile, all of which are influenced by concentration and association. The temperature conditions of the cupelling beads vary constantly, which may change any or all of these conditions. The oxygen supply influences them. Even more important, perhaps, is the extent to which the surface of the metal is covered and protected by the litharge formed. At moderate heats much of the button surface is covered by the litharge and the opportunity for direct volatilization of the metals reduced. Intimately connected with this is the question of secondary volatilization, oxide of lead being volatile, oxide of silver may be dragged along, even if it is not covolatile. No one knows how much, if any, of the lead, or any other metal, present in cupel fumes volatilized before oxidation.

Rose[9] suggests that gold and copper go off as "vaporized alloy" and Mitchell[10] says silver is much more volatile when alloyed with lead. Wright[11] bessemerized silver bullion high in arsenic and the arsenious oxide produced showed about 800 oz. silver per ton. I have roasted rich arsenide ores[12] at a very low temperature and the arsenious oxide given off showed only a few ounces of silver per ton. Mitchell[13] says the litharge fume in cupelling is "produced by the vapor of lead burning in the atmosphere," but gives no data.

Again, other questions of molecular physics are involved. Keller[14] has shown that gold travels into copper on prolonged heating of the alloy below its melting point. So the rate at which the precious metals withdrawn into the cupelling bead must affect the drag. Gillett[15] says that on heating brass, loss of zinc depends, in part, "on the rate of diffusion of zinc from the body of the melt into the surface that is losing zinc."

LOSS THROUGH DUSTING

Many statements regarding volatilization in assaying are based upon data obtained under conditions entirely different from cupelling, and much that has been written

*A paper read at the New York meeting of the A. I. M. E., February, 1920. Published by permission of the Director of the Mint.

†Assayer, Bureau of the Mint.

[1] John Percy: "Metallurgy—Silver and Gold." Pt. I, p. 249. London, 1880.

[2] C. and J. J. Beringer: "Text-book of Assaying," p. 101. London, 1908.

[3] Alfred E. Smith: "Sampling and Assay of Precious Metals," p. 170. London, 1913.

[4] John Mitchell: "Manual of Practical Assaying," p. 484. N. Y., 1872.

[5] L. Campredon: "Guide Partique du Chimiste Métallurgists et de l'Essayeur," p. 305. Paris, 1909.

[6] *Trans.*, A. I. M. E. (1918), vol. 58, pp. 85, 89.

[7] *J. Frank. Inst.* (1919), vol. 187, p. 595.

[8] *Eng. & Mining J.* (1919), vol. 108, p. 87.

[9] *J. Chem. Soc.* (1893), vol. 63, p. 723.

[10] *Op. cit.*, p. 484.

[11] *Eng. & Mining J.* (1918), vol. 107, p. 263, from *Trans.*, Can. Min. Inst. (1918), p. 992.

[12] *Eng. & Mining J.* (1919), vol. 108, p. 87.

[13] "Manual of Practical Assaying," p. 558. 1881.

[14] *Bull.* 145, A. I. M. E. (January, 1919), p. 33.

[15] U. S. Bureau of Mines *Bull.* 73 (1916), p. 125.

fails to distinguish between volatilization and dusting, which is purely mechanical. In practical operations, losses are often ascribed to volatilization that are largely, if not entirely, due to dusting and other mechanical causes.

In modern practical work, there is now probably very little straight cupellation of lead. Where works have lead rich enough to cupel, advantage is generally taken of this to work up other high-grade products, rich ores, slimes, etc. Much of the extremely rich silver ore from Cobalt, Ont., has been treated in this way. These additions, particularly very fine slimes, favor dusting and high silver in fume or dust collected from cupelling furnaces does not prove high volatilization. Iles[16] gives many figures on fumes and dusts from various sources. A mixed cupel fume showed 85.90 oz. silver per ton; this might indicate volatilization, but the fact that it was only 72.50 per cent lead showed dusting, oxide of lead containing 92.83 per cent lead.

Mr. Dieffenbach[17] has furnished a month's record of the results from the Cottrell condensers on the cupel furnaces. The fume collected weighed 24,659 lb. and contained 9,863 lb. lead, or approximately 40 per cent, indicating much dust. This is accounted for by the fact that about 70 tons of slimes was treated on the lead bath. The fume contained 5,830.11 oz. silver, or 0.64 per cent of the silver charged. In view of so much mechanical dusting of rich stuff, the actual volatilization must have been very small. The slimes charged contained nearly 555,000 oz. silver. In a negative way, the figures show that there was practically no volatilization of gold, for notwithstanding the dusting, only 12.07 oz. gold was found in the fume out of 16,855 oz. charged, of which over 13,000 oz. was in the slimes.

Condensation of Assay Muffle Fumes

Various persons have reported the finding of gold and silver in the fumes condensed in the flues of muffles, but these generally show only minute quantities of the precious metals and all lack quantitative significance. Smoot[18] says, "We assayed the condensed fumes from the muffle ventilation pipe and found only a very small amount of silver and practically no gold," and "This seems to indicate, in a qualitative way, that only a negligible amount of silver is lost in the lead fume."

The best figures that I know of regarding the condensation of assay muffle fumes have been supplied by Donald M. Liddell. One muffle was used only in pig copper assay by the combination method. It carried very close to 90 oz. per ton, and the residue from one assay-ton, after burning off the paper, was scorified with one assay-ton lead down to about 7 g., which was cupelled in the same muffle. The muffle had a small forced-draft apparatus at the back and all fume passed through an iron pipe, which formed a fairly efficient condenser. This pipe was cleaned out every six months, during which time about 5,500 assays were made, yielding about 175 g. of litharge. One lot of 175 g. gave 142.7 mg. silver, but not enough gold to weigh. This would roughly mean the volatilization of about 0.026 mg. silver per assay, or approximately 0.03 per cent. It would seem fair to divide this between the scorification and cupelling, estimating the cupel volatilization as 0.015 per cent.

[16] *Sch. Mines Qr.* (1899), vol. 20, p. 397.
[17] Superintendent of the Balbach Smelting & Refining Co., Newark, N. J.
[18] Personal letter.

Johnston[19] has published a most valuable review on the vapor pressure and volatility of several high boiling-point metals, giving many references, particularly of exact scientific investigations. The ultimate object of this paper was to devise a formula for determining the approximate volatility of various metals at different temperatures. The data regarding gold, however, were too scanty for this. There is absolutely no connection between melting point, vapor pressure, and boiling point. Various metals show vapor pressure below their melting point. Tin, with a melting point of 232 deg., is said to boil at about 2,300 deg., while copper, with a melting point of 1,083 deg., is said to boil about 100 deg. above tin.

Volatility of Gold

Varied statements have been made regarding the volatility of gold. Gmelin[20] says, "It exhibits a scarcely perceptible volatility at the strongest heat of a blast furnace, in the focus of a burning mirror, and in a flame fed with oxygen gas." Napier[21] appears to have been the first to make systematic tests and is often quoted, but his figures are small, about 0.1 per cent, and the time of heating long, 3 to 8 hr. Makins[22] is often quoted, but his figures are extremely small, even though an extraordinary heat was used in the cupellations; there is no connection with the amount of gold operated on; he simply found 0.087 g. of gold in 1,000 g. of flue dust. The volatility of gold before the extreme heat of the blowpipe is described in Crookes.[23]

Seamon and Parker[24] heated beads of gold, 1 to 20 mg., varying periods of time, to temperatures from 1,000 to 1,650 deg. Losses were observed only twice and were attributed to unobserved errors of manipulation. Under the conditions of a cathode-ray vacuum, on prolonged heating, Krafft and Bergfeld[25] were able to observe volatilization of gold at 1,070 deg. Moissan[26] places the boiling point at 2,530 deg. Mostowitch and Pletneff[27] state that in oxygen, nitrogen, carbon monoxide, and carbon dioxide at 1,400 deg. volatilization is not appreciable, but is noticeable at 1,250 deg. in hydrogen. Kern and Heimrod[28] made extensive tests on the volatility of gold and silver, obtaining some interesting results, but their conditions were quite different from cupellation. Many hours heating in contact with carbon did not volatilize silver from copper, but did volatilize gold from copper, possibly by the formation of a carbide of gold. Incidentally, their quotation from Napier is faulty. Wurtz[29] gives a review of early information.

T. K. Rose has been a prolific investigator of this subject and his books and papers contain many references. In 1893 he stated[30] that volatilization of gold begins just below 1,100 deg. and at 1,250 deg. the loss per min. was four times as great as at 1,100 deg., the loss on a charge of 1,200 oz. was figured to be 0.02 per cent per hr.; the volatilization in cupellation was insignificant. Later he says[31] that the loss in an ordinary melting furnace is

[19] *J. Ind. Eng. Chem.* (1917), vol. 9, p. 873.
[20] Leopold Gmelin: "Handbook of Chemistry," tr. by H. Watts; vol. 6, p. 205. London. 1852.
[21] *J. Chem. Soc.* (1858), vol. 10, p. 229.
[22] *J. Chem. Soc.* (1861), vol. 13, pp. 98-9.
[23] "Select Methods," p. 443. 1886.
[24] *Bull.* Missouri Min. Club (1895), vol. 1, p. 16.
[25] *Ber.* (1905), vol. 38, p. 254.
[26] *Compt. Rend.* (1905), vol. 141, p. 977.
[27] *J. Russ. Met. Soc.* (1915), p. 410, Abs. MET. & CHEM. ENG., (1917), vol. 16, p. 153.
[28] *Sch. Mines Qr.*, vol. 33, pp. 34-64.
[29] *Eng. & Mining J.* (1885), vol. 40, p. 126.
[30] *J. Chem. Soc.* (1893), vol. 62, p. 714.
[31] *Ann. Rpt.* British Mint (1906), p. 60; Abs. *Eng. & Mining J.* (1907), vol. 84, p. 297.

seldom over 0.01 per cent on 1,200 oz. and is influenced by temperature, metal surface exposed, and time, and is increased by air passing over the metal and by impurities. Still later[32] he says, "True volatilization of gold is so small as to be negligible at the temperature of industrial melting furnaces, say 1,000 to 1,300 deg. It is difficult to measure with accuracy the infinitesimal amounts volatilized at these temperatures." "Even in a strong draft the amount volatilized remains exceedingly small" provided the nature of the gas does not change. Alloys, however, may take up and eject gases with spurting, which may give globules less than 0.001 mm. in diameter, which may be carried away by even a slight draft and are difficult to recover. The first table of results, p. 4, is an excellent illustration of a fact I have often met in the literature and in my own experience with gold; that is, the effect of unrecognized conditions leading to erratic results when expecting regularity.

In a paper on accuracy in assaying, Rose[33] attempted to follow the course of the gold and gives results from which he concludes that while final loss is shown in each case it does not represent the amount volatilized with certainty, errors of five determinations being accumulated here. I would add that he determined the silver and other metals left in his cornets in a lump by a reassay, which must have been subject to all the errors of the original assay.

Hillebrand and Allen[34] give some figures upon volatilization, but they exhibit serious irregularities. On gold alone two cupel recoveries exceeded the total loss and the volatilization figure on No. 4 cupel was more than twice No. 6, two cupels behind. In series B, Table IX, 15 mg. gold, 45 mg. silver, No. 3 showed a higher figure for gold volatilization than No. 6, three cupels behind it in the furnace, and on silver No. 4 showed more than No. 6. While the total losses show considerable regularity from front to back of the furnace, the ratios between volatilization and absorption are erratic. The possibility of losing gold mechanically in decanting and washing was not provided for in the volatilization tests.

Schneider[35] attempted to determine volatilization by cupelling 450 mg. gold, 50 mg. copper, 1,200 mg. silver, 4 g. lead, recupelling the resulting bead with 4 g. lead and repeating eight times. When properly carried out, this method might give a good approximate, but Schneider generalized as to some of his figures and assumed that no gold went into his nitric acid, although he assayed the ten cupels for gold and silver absorbed.

I have done considerable work in trying to arrive at a figure on volatilization of gold in cupellation by the examination of the products of the operation. No determination of volatilization depending in any way on the weight alone of a bead or cornet can be convincing. The normal bead is never pure precious metal. Cornets always carry silver and copper and often lead. Gold goes into the parting acid and into the cupel. After actually determining these items and balancing the results, we get a figure which might be called volatilization, but it is a different figure and bears the errors, both plus and minus, of much analytical work; therefore it must be handled with judgment. Sometimes the figure indicates an appreciable loss; sometimes it gives practically a balance, indicating no loss; a gain also has been shown.

All these points are shown in one test. The San Francisco mint prepared an ingot of standard gold, 900 gold 100 copper, for test purposes. It was extremely close to 900 fine in gold. Three sets of nine assays, three rows of three, were run at three temperatures, the regular heat for this work, very low, and very high. The regular heat showed a slight loss of gold. The very low heat showed a gain. The very high heat, which should have favored volatilization of the gold, gave practically a balance, the figures showing a loss of only 0.005 mg. for the set. The figures are as follows:

	Regular Heat, Mg.	Very Low Heat, Mg.	Very High Heat, Mg.
Silver in cornets	3.51	3.55	3.02
Copper in cornets	0.31	0.23	0.32
Lead in cornets	trace	trace	trace
Total in cornets	3.82	3.78	3.34
Cornet weight	1.375+	2.35+	2.425−
Gold lacking	2.445	1.23	5.765
Gold from solution	0.125	0.20	0.200
Gold from cupels	2.14	1.49	5.56
Balance	0.18−	0.46+	0.005−

From these figures it is evident that there is no necessity for running coin gold, and by fair inference fine gold, at such a heat as to favor the volatilizing of gold during cupellation. The high loss of weight of the cornets at the very high temperature could not be tolerated as a regular practice and such a temperature would not be used regularly.

Volatility of Silver

Silver is far more volatile than gold. Gmelin[36] states that it boils by the burning mirror when it rises in white fumes and that it volatilizes in an open crucible at incipient white heat, but not if covered with charcoal dust. In a cathode-ray vacuum, Krafft and Bergfeld[37] observed volatilization at 680 deg. Johnston[38] gives its melting point at 960 deg. and its boiling point at 2,090 deg. He calculates that it has a vapor pressure of 10^{-3} mm. at 920 deg. and 1 mm. at 1,320 deg. In his atomic-weight work, Stas[39] distilled silver to purify it.

Richards[40] proposed to separate silver from blowpipe beads by volatilization. Over 95 per cent of the silver was to be removed by heating before a sharp-pointed oxidizing flame to 1,100-1,200 deg. estimated and the balance removed at about 1,500 deg. estimated, at which temperature the gold begins to volatilize. In a subsequent paper,[41] on measuring buttons, he said, "It is difficult to drive off all the silver, as the last 5 to 10 per cent volatilize slowly and probably also take a little gold with them," furnishing an excellent illustration of the drag of a volatilizing metal upon a less volatile associate as well as the stabilizing effect of a less volatile metal upon a volatilizing one.

In a little-known and short-lived journal,[42] Seamon and Parker describe extensive tests on cupellation. As a preliminary, they made many tests on beads of silver 999 fine, of various weights up to 80 mg., for various times up to 4 hr., at various temperatures 900 to 1,600 deg., by simply heating them in cupels. At the conclusion of the heating all the cupels showed a brownish spot

[32]Inst. Min. Met, March 20, 1919, see *Eng. & Mining J.* (1919), vol. 107, p. 839.

[33]*J. Chem. Soc.* (1893), vol. 63, p. 700.

[34]*Bull.* 253, U. S. Geol. Survey (1905), pp. 20, 21.

[35]*Oesterr. Z. Berg.- u. Hüttenw.* (1906), vol. 54, p. 98.

[36]*Op. cit.*, p. 138.

[37]*Op cit.*

[38]*Op. cit.*

[39]*Mem.*, Acad. Roy. de Belgigue (1865), vol. 35. See Crookes' "Select Methods," p. 282.

[40]*J. Frank. Inst.* (1898), vol. 141, p. 447.

[41]*J. Am. Chem. Soc.* (1901), vol. 23, p. 200.

[42]*Bull.* Missouri Mining Club (1895), vol. 1, p. 16. It should be noted that in this paper per cent losses are figured upon the weight of the resulting bead and not on the weight of silver taken.

below the beads. Several cupels were tested qualitatively for silver, which was always found. They proposed to make qualitative determinations of the silver absorbed, but I have not found such results published. The results are somewhat irregular. In one set of eight, on beads 5.09 to 22.50 mg., at 900 deg. to 1,000 deg. for one-half hr., each one showed a loss of 0.02 to 0.07 mg., while another set of six, 20 to 80.06 mg., at the same temperature for 1 hr., showed no losses. They conclude that at 1,000 deg. "the loss appears to be mainly due to the oxidation of the silver and absorption of the oxide by the cupel," but at high temperatures volatilization may become important. Under their conditions 960 to 1,020 deg. barely gave feathers in cupellation.

I have done much work in checking up and extending this line of tests. Seamon and Parker appear to consider 999 silver as entirely satisfactory, but it is far from being pure and the impurity might influence the result. I used five grades of silver: proof of the highest purity, parting silver of high grade but not up to proof, ordinary silver reduced from the chloride by zinc, 50 g. parting silver melted with 50 mg. lead, 50 g. parting silver melted with 50 mg. copper. Under small beads it was only with the copper sample that the stain was plainly visible. With large beads four of the silvers stained the cupel and sometimes adhered closely to it: parting silver was not tested on large beads. Both large and small beads often showed a white coating. The figures showed irregularities and were larger than Seamon and Parker found, but I was forced to the conclusion that it was futile to expect to obtain exact or even comparative figures and discontinued the tests.

Exposure of molten silver to the air leads to a mixed result. There is oxidation of the silver and maybe volatilization. The oxidation products may be absorbed by the support in part only and part may remain in or on the metal. The loss shown by weighing the silver before and after such exposure cannot lead to definite results on any point.

Relations of Silver and Oxygen

Many and most contradictory statements have been made regarding the relations of silver and oxygen, both chemical and physical. The subject is greatly in need of clarification. It is apparent that they unite in various proportions.[43] While Ag_2O loses oxygen at very low temperatures and is said to be entirely decomposed[44] below 350 deg., pure silver prepared in the ordinary way gave off oxygen at 400 to 500 deg. for 6 hr. at the rate of 57 c.c. for a kilo of silver.[45] Silver and oxygen certainly combine at much higher temperatures and separate on lowering the heat.[46] Watts[47] says there is an oxide of silver volatile at high temperatures. Possibly this is based upon Plattner,[48] whose statements are questioned by Percy[49] and were further investigated by Christy.[50] Wartenberg[51] found silver appreciably more volatile in oxygen than in nitrogen and attributes this to the formation of silver oxide at high temperature, which may then possibly exist as a gas owing to its high heat of vaporization. Various writers have stated that sublimed silver often contains oxide of silver. Troost and Hautfeuille[52] say protoxide of silver exists in the very hot gases. Gmelin says, "Silver at a white heat decomposes aqueous vapor . . . taking up oxygen," but on the next page says, "Silver does not oxidize in dry or moist air at any temperature below its boiling point." He also says silver "is less oxidized than platinum by fusion in the air."

T. K. Rose[53] says, "Even platinum was much more readily oxidized than silver," but in a previous paper[54] on refining by blowing air through molten bullion and fluxing the oxides produced he brought bullion 354 fine in gold and 621 fine in silver up to 885 gold and 103 silver. In comparing his process with cupellation, he says, "Later, when the percentage of silver is high, it is freely oxidized in both processes, and the oxidation is at its maximum when the silver is practically pure." He says the "whole trend" of his work "is to show that it is silver that carries oxygen to base metals" and does not consider base metals oxygen carriers to silver. In this he appears to be dominated by theoretical considerations regarding normal oxides, Ag_2O and PbO for instance, and to overlook the possible interaction of other oxides.

The well-known spitting of silver in solidifying has been generally assigned to the evolution of oxygen, but it has also been ascribed to the compression[55] of the solid crust on the molten interior. Having cooled large buttons, 7 to 10 g., with extreme slowness and having obtained projections in the general form of a large irregular, inverted, hollow cone, in some instances only one cone on a button, I am satisfied that compression contributes to the spitting of solidifying silver. I have also produced spitting by the sudden cooling of a bead by contact with a mass of cold iron. In this connection it is certainly significant that silver melts and solidifies at a lower temperature in oxygen than in a reducing atmosphere.[56] Aside then from the natural cooling and solidifying of the surface first, the interior retains a lower melting point and remains liquid longer than the exterior, which has lost oxygen with the consequent raising of the melting point. The non-spitting of silver containing other metals may be due to changed differentials in the melting points.

Volatility of Lead

Johnston[57] gives the boiling point of lead as 1,640 deg. and the vapor pressure as 1 mm. at 960 deg. Krafft and Bergfeld[58] give 335 deg. as their lowest observation of volatilization of lead in a cathode ray vacuum. Schuller[59] and Kahlbaum, Roth and Siedler[60] distilled lead *in vacuo*, and the latter obtained a crystalline product. Roberts[61] showed that with proper care there was no appreciable volatilization of lead in melting assay samples of base bullion. From the distillation of alloys, Moissan and Watanabe[62] announced that the order of distillation is lead, silver, copper, tin. The litharge cloud

[43]Watts *Dict.*, vol. 5, p. 302; Roscoe and Schorlemmer, vol. 2, pt. 1, p. 367; Brown: *Trans.*, Am. Electrochem. Soc. (1916), vol. 30, p. 327; Weber: *Idem.* (1917), vol. 32, p. 391.

[44]Percy: *Op. cit.*, p. 8 et seq.: Thorpe's *Dict.*, vol. 4, p. 700.

[45]Watts *Dict.*, vol. 8, pt. 2, p. 1,798.

[46]Percy: *Op. cit.*; Donan and Shaw: J. Soc. Chem. Ind. (1910), vol. 29, p. 987. Watts *Dict.*, vol. 5, p. 278 and others.

[47]*Dict.*, vol. 5, p. 278.

[48]"Röstprozessen," p. 121 (1856).

[49]*Op. cit.*

[50]*Trans.*, A. I. M. E. (1888), vol. 17, p. 67.

[51]*Z. Electrochem.* (1913), vol. 19, p. 482; *Z. anorg. Chem.* (1912), vol. 79, p. 76. See *J. Am. Chem. Soc.* (1914), vol. 26, p. 234.

[52]*Compt. Rend.* (1877), vol. 84, p. 948.

[53]*Trans.*, Inst. Min. and Met. (1913-4), vol. 23, pp. 173-4.

[54]*Idem.* (1904-5), vol. 14, pp. 377, 420, 440-1.

[55]Mitchell: "Manual of Practical Assaying," p. 480 (1872).

[56]Ruer: "Metallography," tr. Mathewson, p. 296.

[57]*Op. cit.*

[58]*Op. cit.*

[59]*Wied. Ann.* (1883), vol. 18, p. 321.

[60]*Z. anorg. Chem.* (1902), vol. 29, p. 278: *Bu. H. Zeit.* (1902), p. 296.

[61]*Trans.*, A. I. M. E. (1898), vol. 28, p. 425.

[62]*Compt. Rend.*, vol. 144, p. 16.

that is given off during cupellation is very deceptive. It makes an impressive showing in the muffle, but the actual weight of oxide of lead is slight.

More than fifty years ago Mitchell[63] announced that in the ore-assay cupellation "not more than 2 to 3 per cent of lead is volatilized"; I have abundantly verified this statement. By weighing the cupels before and after use, I have found that it is quite possible to run an ordinary 20-g. button with the volatilization of about 0.5 g. of lead. This, however, involves some risk of freezing and requires much attention. At only a slightly higher temperature, with an increase of the volatilization to 0.75 g., there is no risk of freezing and the operator may simultaneously look after other things. When the volatilization rises to 1 g. there is but slight feathering unless special condensing arrangements are used. In one test, three cupels of the front row showed less than 2.75 per cent volatilized and the fourth froze, while the second row of four showed from 5.5— to 6— per cent volatilized and there were few feathers. With larger buttons, 50 to 60 g., seven cupels showed less than 2 per cent volatilized, with a minimum of 1.4 per cent. In the cupellation of bullion,[64] where necessarily a higher temperature is used, the volatilized lead should not exceed 10 per cent.

Most contradictory statements have been made regarding the volatility of oxide of lead. The assayers' daily experiences disprove the statements of various textbooks as to its volatilizing only at a high temperature. The books appear often to be speaking of boiling[65] rather than simple volatilization. However, the boiling point, 870 deg., given by Mott[66] is palpably much too low. Doeltz and Grauman[67] say volatilization was slight at 800 deg., increased rapidly to 900 deg., when it became liquid, not so rapidly to 950 deg. and was not tested above 1,000 deg. By changing the ratio of surface to mass, they varied the loss from 8.8 to 0.04 per cent at 900 deg.

Feathering as an Indication of Temperature Conditions

Feathering is not always a sure indication of the temperature conditions of the bead. With high bead temperature and an abundant air supply the cupel may show good feathers, while the same bead temperature with limited air supply would not. Lack of feathers, particularly on inside cupels, may be due to lack of cooling conditions above the cupel, instead of high bead temperature. In two well-feathered cupels, Hillebrand and Allen[68] found 0.05 mg. loss of gold on 10.67 mg. cupelled, but only 0.03 mg. on 15.56 mg. The cupels immediately behind these showed 0.06 and 0.17 mg. losses, respectively. It is possible that lack of feathers may also be due to a leaky muffle.

Effect of Other Metals on Volatilizing of Gold and Silver

When true volatilization occurs in quantity, the volatilizing metal exerts a drag upon its less volatile associates, but the real data upon the subject indicate that in the vast majority of cases this drag is but slight. Bodemann and Kerl[69] say silver is often disposed to volatilization by arsenic, antimony, zinc and lead.

T. K. Rose[70] says that the presence of zinc, arsenic, antimony and other volatile metals is believed to greatly increase the volatilization of gold, but gives no data. Hellot[71] says an alloy of one part gold and seven parts zinc volatilizes completely at a high heat, but Friedrich[72] investigated the subject and reported fifteen tests, from which he concluded that the loss was mainly due to mechanical action and it is only with rapid volatilization of zinc that the gold volatilization becomes appreciable. Up to 1,500 deg., the loss was so slight as to warrant the conclusion that zinc has no influence in promoting the volatilization of gold below this temperature. I have shown[73] that in distilling the zinc out of Parkes crusts, very little silver goes over in proper work and that volatilizing lead carries but slight amounts of silver. I have also shown[74] that irregular assay results may be due to zinc carrying the precious metals to the surface of the cupel. It may well be that arsenic and antimony cause irregular assays in the same way rather than by volatilization. I have shown, too, that[75] the roasting of rich arsenide ores at a low heat produced arsenious oxide practically free from silver. In some recent tests we have obtained much more concordant results than those reported on arsenical bullion.[76] The assays were run in sets of six, two rows of three cupels with proofs in the center; two sets were run on 5 g. lead and one on 8 g. on each bullion. The results were:

No. 1		No. 2	
Gold	Assays	Gold	Assays
665.5 fine	1	811.3 fine	1
665.6 fine	2	811.4 fine	2
665.7 fine	4	811.5 fine	3
665.8 fine	4	811.6 fine	1
665.9 fine	6	811.7 fine	3
666.1 fine	1	811.8 fine	5
		812.0 fine	3
	18		18

The arsenic in No. 1 was high but unknown, in No. 2 it was about 10 fine with, approximately, 90 each of silver and copper.

It is often claimed that tellurium promotes volatilization in cupellation, but T. K. Rose[77] carried on an extensive series of tests under many conditions and in only one was gold found in the condensed tellurium. Holloway and Pearse[78] say, "Loss by direct volatilization is very slight under proper conditions of working," and on cupelling beads containing tellurium with proofs without tellurium in side by side cupels some tellurium beads lost less than the proofs.

In retorting gold amalgam, Rose[79] states that about one grain of gold goes over per lb. of mercury. Although outside the scope of this paper, it may be mentioned that the recent volumes of *Transactions* of the American Electrochemical Society contain much interesting information regarding the action of metals, alone or mixed, at the very high temperature of the electric arc; and in 1907, Watts reviewed the work of Moissan.

Determination of Silver by Cupellation

The method I used in following up the course of the gold in a bullion assay is not applicable to silver. The determination of silver by cupellation[80] is quite unreliable and with large amounts the absorption of silver by

[63] *Op. cit.*, p. 484. Tests are given by Lodge: "Notes on Assaying," p. 56, and Liddell, *Eng. and Mining J.* (1910), vol. 89, p. 1,264.
[64] *Trans.*, A. I. M. E. (1918), vol. 59, p. 214.
[65] Wagner: "Die Metalle," p. 111 (1866).
[66] Am. Electrochem. Soc. pamphlet, 1918.
[67] *Metallurgie* (1906), vol. 3, p. 406.
[68] *Op. cit.*, p. 21.
[69] "Assaying," tr. Goodyear, p. 103 (1878).

[70] *J. Chem. Soc.* (1893), vol. 63, p. 714.
[71] Gmelin-Kraut: "Handbuch anorg. Chem.," vol. 3, p. 1,039.
[72] *Z. anorg. Chem.* (1893), vol. 16, p. 269.
[73] *Eng. and Mining J.* (1919), vol. 108, p. 87.
[74] *Trans.*, A. I. M. E. (1918), vol. 58, p. 85.
[75] *Op. cit.*
[76] *Trans.*, A. I. M. E. (1909), vol. 40, p. 795.
[77] Br. Asso. Rpt. (1897), pp. 623-4.
[78] Inst. Min. and Met., vol. 17, p. 171.
[79] "Gold," p. 141.
[80] *J. Ind. & Eng. Chem.* (1914), vol. 6, pp. 650, 728.

the cupel[51] is most erratic. On the other hand the determination of the base metals left in small beads is unsatisfactory unless we have an exceedingly large number of identical beads. In another connection, I have shown[52] that the straight assay of a silver bullion showed 987 fine, which corrected for the cupel absorption became 998.5 fine, while cupellation with proof showed 999.3 fine. Liddell[53] gives some very interesting tests on cupellation, but he determined the "fineness" of his beads, and this was subject to the errors of the original assay. Both these tests lack conclusiveness.

L. Campredon's book[54] says that all the silver lost is absorbed by the cupel, but the tests lack the determination of base metals in the beads. G. Campredon[55] made three tests in duplicate at a high temperature, one set using five times as much copper as silver, but he made no examination of his buttons. His result varied from nothing to 2.10 per cent on 100 mg. silver. He made two assays of his cupels; one for beads on the surface, which varied from 0.40 to 1.50 per cent, and one for absorption. Various other indirect tests have been made, but all lack important data. Some tests show a gain even when the recoveries of silver were not complete.

It remains then that the only way to determine the volatilization of silver in a cupellation is to collect the litharge volatilized and assay it for silver. Manifestly this is also the only real way to ascertain the volatilization of gold under assaying conditions. I started out to do this without interfering with the normal conditions of cupellation, but found it impossible to do so in an ordinary muffle in constant use for regular work. Various arrangements of temporary baffle plates proved inefficient condensers and in many cases the condensed litharge entered into combination with the plate material. While it is possible by the use of special cooling arrangements to grow a large crop of feathers on the cupel, once the fume got out of the cupel it was practically impossible to stop it. Of course with a small muffle provided with special condensing flues, such as a Cottrell tube, and running a large number of identical assays a good approximation may be obtained, but I did not have these conditions. Again, with the low rate of volatilization of the lead in a proper cupellation of an ordinary 20- to 30-g. button, the best feather-growing arrangements will yield only insignificant amounts of litharge. Feathers are most deceptive; they bulk large but weigh light.

After various tests I made a very deep cupel with straight sides. In the early tests the condensation of litharge was erratic, varying from 0.2 to 1 g. and considerable experimenting was required to develop a satisfactory procedure. With 100 g. lead and 1 g. silver 0.605 g. litharge condensed, yielding 0.055 mg. silver; with 5 g. silver 0.735 g. litharge gave 0.26 mg. silver; with 133 g. lead and 6 g. silver, 0.97 g. litharge gave 0.26 g. silver; with 140 g. lead, 2.11 g. copper, 8.33 g. silver, 0.465 g. litharge gave 0.27 mg. silver. By using large amounts of lead, placing the cupel close to the front of the muffle and filling in around it so as to force all the draft over the cupel, and by protecting the cupel from radiation from the muffle top, I was able to condense a gram or more of litharge for assaying. This is none too much, even when cupelling very rich lead.

[51]*Trans.*, A. I. M. E. (1918), vol. 59, p. 191.
[52]*J. Am. Chem. Soc.* (1894), vol. 16, p. 514.
[53]*Eng. and Mining J.* (1910), vol. 89, p. 1,264.
[54]*Op. cit.*, p. 307.
[55]*Rev. Univ. des Mines* [4] (1904), vol. 8, p. 210.

A most serious objection to this method is that in time the surface of the bullion sinks out of sight. As one cannot see the end of the cupellation, careful watching and much judgment is required in turning off the gas. In ten tests, six buttons weighed more than the silver taken, the maximum being 3.4 g. on 1 g. taken and the minimum 0.13 on 5 g. taken. Of the four losses, the maximum was 0.46 on 5.81 g. and the minimum 0.04 on 5.045 g.

In general, 140 g. of lead was taken, the smallest amount of gold used alone was 140 mg., which would correspond to 20 oz. per ton in a 20-g. button from an assay-ton fusion. The largest was 1.4 g.. or 200 oz. per ton. The following results were obtained. In the last test only 105 g. of the lead was oxidized.

Gold Taken, g.	Litharge Recovered, g.
1.40	1.45 containing 0.09 mg. gold
1.40	1.176 containing 0.02 mg. gold
0.70	0.876 containing 0.01 mg. gold
0.140	1.213 containing trace
0.140	0.725 containing speck

A sample of the celebrated Mercur bullion, about 884 fine in gold and less than 8 fine in silver, 1.6 g. yielded 1,185 g. litharge containing 0.03— mg. gold. Samples of miscellaneous bullion, most of them presenting unusual difficulties in ordinary assay work, yielded the following results:

Bullion weight, Grams	Fineness		Recovered		
	Gold	Silver	Litharge Grams	Gold, Mg.	Silver, Mg.
3.5	808	34	0.92	None	Slight trace
2.5	585	95	1.45	Speck	0.02
2.5	585	316.5	1.312	Very slight trace	0.015
4.0	361	228.5	1.32	0.01	0.08
4.2	343.5	443	1.13	0.005	0.16
6.75	211	225	0.95	0.005	1.26

In the last test, a scum appeared early and crystals were slow in forming; probably some of the scum adhered to the feathers recovered.

With 1 per cent, 1.4 g., gold, and 3 per cent, 4.2 g., silver, 1.27 g. feathers showed a very slight trace of gold and 0.21 mg. silver. In one test the lead carried about 1 per cent arsenic, but the cupel cracked. With 0.5 per cent arsenic and 1.4 g. gold, 1 g. litharge was collected and the gold obtained was estimated at 0.002 mg.

Three grades of base bullion were tested—good, bad, and very bad for assaying. Using 159.5 g. of the first gave a button weighing 1.24 g., 0.762 g. litharge was collected, which gave a bead of 0.08 mg. The second would not cupel direct, but 20.03 g. was run with 152.45 g. proof lead and gave a button weighing 3.475 g.; 0.975 g. litharge was collected giving a bead of 0.08 mg. In a second test, the figures were bullion 20.62 g., lead 142.45 g., button 3.422 g., litharge 1.322 g., bead 0.28 mg. Probably the high litharge and bead were due to the early formation of an unabsorbed scum on the cupel, upon which later feathers formed, particles of which adhered to the litharge recovered. The third sample yielded the highest recovery of litharge of any test made, 1.50 g., due perhaps to the same causes. The figures were, bullion 20.79 g., lead 139.06 g., button 3.25 g., litharge 1.50 g., bead 0.30 mg. Extreme tests were made on three grades of silver—proof, 900 silver 100 copper, 750 silver 250 copper. Starting with 2 and 3 per cent actual silver on the 140-g. lead buttons, the results were:

	2 Per Cent Silver Litharge		3 Per Cent Silver Litharge	
	Weight, g.	Silver, Mg.	Weight, g.	Silver, mg.
Proof	1.04	0.24	1.28	0.26
900	1.16	0.20	0.97	0.26
750	1.24	0.21	0.71	0.21

Legal Notes

By Wellington Gustin

Cherokee Fertilizer Company Wins Judgment

From Georgia comes a case wherein the Cherokee Fertilizer Co. brought an action on a note against one J. A. Smith, recovering a judgment thereon in the lower court which was affirmed on appeal (100 S. E., 719). Justice Luke delivered the court's opinion.

It appears from the evidence that the fertilizer company had a suit pending against Smith for several thousand dollars, and a settlement of that case was had between the parties, and the case marked settled upon Smith paying certain money and delivering certain stock to the company. The payment was made and received in full settlement of that claim, and a receipt given and marked in full payment of all claims to date.

Subsequently the present suit was instituted upon a note signed by Smith and another which was not mentioned by either of the parties at the time of the settlement. In fact, the attorneys representing both testified that neither of them knew about the note. The defendant Smith pleaded that there was a full settlement because of the receipt in the settlement above indicated.

The court said that if one who had several different demands against another accept payment of one or more and gives a receipt therefor, there being at the time no mention of the other demands, a mere recital in the receipt that it is full payment of all claims to date is without consideration so far as relates to an unsettled note signed by the party making the payment, and another which was not mentioned or in the minds of the parties at the time of such settlement and the signing of the receipt, does not estop the holder of the unsettled demand from asserting that demand, nor does the signing of the receipt render it incumbent upon the holder of that demand to refund the money received upon the settlement as to the disputed claims.

Detroit Chemical Works Wins Case

The Supreme Court of Michigan has affirmed the judgment in favor of the Detroit Chemical Works of Detroit, in the action brought against it by the Dow Chemical Co. of Midland, Mich. The parties had entered into a written contract whereby the latter agreed to purchase 900 net tons of sulphuric acid, commercial grade, of approximately 60 deg. Bé. strength, from the former company according to certain terms and conditions as stipulated. This contract was executed on June 8, 1915; the price was $12 per ton, f.o.b. vendor's tank cars, Detroit, Mich., less freight to Midland; the deliveries were to be made at the rate of about seventy-five tons per month beginning Jan. 1, 1916; the terms of payment were net cash in ten days.

The conditions in the contract pertinent to this case were: "Each shipment to be treated, for the purpose of settlement, as a separate and independent sale, but if buyer fails to make payment for any materials furnished by vendor according to terms of sale, said vendor may defer additional shipments until payment is made, or may cancel this contract at his option. . . . The vendor reserves the right to decline to make deliveries on this contract except for cash whenever said vendor shall have any doubt as to buyer's responsibility and so informs buyer. Deliveries to be renewed according to contract terms when buyer shall have satisfied vendor as to his responsibility."

Facts Out of Which the Suit Arose

On Jan. 20, 1916, the Dow Chemical Co. wrote to the Detroit Chemical Works: "There is due on our contract seventy-five tons of 60 deg. acid this month. This is approximately two cars. Please make shipments about three or four days apart." On Jan. 22 the defendant replied: "We are shipping you one car today, in compliance with your request, and a second car will follow the latter part of next week, which we trust will be satisfactory." The first car was shipped and invoiced as of that day, the invoice reaching plaintiff on Jan. 27, the car arriving in Midland on Jan. 29, and was not delivered at plaintiff's plant until Jan. 31.

On Feb. 3 plaintiff wrote: "Please rush shipment of the balance of sulphuric acid due on our contract for shipment during January. Also get the February quota out for us. These cars may be distributed approximately in even shipments over this month." On this same day and before receiving this letter, defendant had shipped the second car. It was billed out as of Feb. 3, but did not reach Midland until Feb. 8. It was not received by plaintiff until Feb. 19. This was considered by both parties as in fulfillment of the January quota.

On Feb. 7 defendant wrote plaintiff a letter, declaring its election to cancel the contract between the parties. It sets out that payment for the first shipment of Jan. 22 matured Feb. 1, and no remittance had been received to cover. This reached plaintiff on Feb. 10 and on the same day its agent went to Detroit and paid defendant for the first car shipped, and on Feb. 12 plaintiff paid for the second shipment of Feb. 3.

Contentions of Defendant and Plaintiff

Defendant refused to make further shipments as requested by plaintiff, claiming it had cancelled the contract by its letter, and that it had the right to do so. Plaintiff was compelled to buy acid in the open market, and brought this suit to recover the damage it sustained by reason of the failure of defendant to furnish the acid according to the contract.

It was the contention of plaintiff that it was not required to pay for the acid, according to the terms of the contract, until ten days after its delivery to it at Midland and a reasonable time allowed for the inspection thereof. Also it contended that by making the shipment on Feb. 3 defendant waived the default of plaintiff in not having paid for the car shipped within ten days after Jan. 2, and that thereby it became estopped from canceling the contract as it attempted on Feb. 7.

Court Construes Contract of Sale "Net Cash in Ten Days"

Over plaintiff's objection defendant offered proof of a general custom of trade by which the language of the contract, "Terms of payments: Net cash in ten days," was construed to mean payable in cash within ten days after date of invoice or shipment. After the evidence was all in, the court directed a verdict for the defendant, holding that it was justified in terminating the contract for the reasons stated, and that there was no waiver of its terms which prevented it from relying on such cancellation as a defense in this suit.

On the appeal the two major questions presented to the Supreme Court were: When was the payment due

of the invoice of Jan. 22? And if the right to cancel the contract accrued to the Detroit Chemical Works by reason of the delay in the payment of the invoice, did this company by its conduct waive that right?

JUDGMENT FOR DEFENDANT AFFIRMED

The Supreme Court said that in view of the uniform sales act as adopted under contract of sale of sulphuric acid of a certain grade, deliverable in installments f.o.b. vendor's tank cars at vendor's city, less freight to buyer's city, terms net cash in ten days, the ten days' time began to run on delivery on board vendor's tank cars at its city and consignment of the car to the buyer; for the contract provision as to deduction of freight to buyer's city did not amount to naming such city as the point of delivery, and the right to inspect, implied from the specification of a particular grade of acid, did not postpone delivery and passage of title until inspection and acceptance, as title to goods may pass even though the right to acceptance be reserved.

Again, under the uniform sales act, where the installment sale contract expressly gave the seller the option to cancel for default in any payment, such right to cancel was not affected by a provision that each shipment was to be treated, for the purpose of settlement, as a separate and independent sale.

On the question of waiver the court said that where payment on an installment sale contract was due Feb. 1, shipment by seller of another installment on Feb. 3, not knowing whether payment due Feb. 1 was in the mail, would be held not a waiver of failure to pay Feb. 1, for "waiver" implies the intentional abandonment of a right by a person entitled to exercise it, who has at the time full knowledge of the existence of the fact on which the right depends, and the facts relied on must also show that such intent was communicated to and understood by the party claiming the waiver; it being, in effect, the abandonment of a particular obligation and an agreement to substitute another in its stead.

Neither was the seller prevented, because of its own default, from taking advantage of its right to cancel installment contract of sale for failure of buyer to make payment due Feb. 1, where although seller had not made the last January shipment during that month, it made such shipment Feb. 3; it not knowing until about the date of its cancellation, which was after Feb. 3, that the Feb. 1 payment was not mailed by buyer on Feb. 1, so that the seller was not in default when it exercised the right of cancellation or knew of facts justifying cancellation. Judgment for defendant was therefore affirmed.

A Controversy in Pig Iron Sales

A judgment for E. C. Humphreys Co. and against Rathbone Mfg. Co. has been affirmed by the Supreme Court of Michigan. The former is located in Detroit and sells pig iron on a commission basis, while the latter manufactures soft gray iron castings at Grand Rapids. On Nov. 19, 1917, plaintiff sold defendant a car of No. 1 iron to be paid for not later than Jan. 20, 1918. It was delivered to defendant, in Grand Rapids, who refused to accept because it did not grade up to No. 1 iron. Subsequently by agreement the price was reduced 50c. a ton, and defendant accepted it, but never made payment for same. About Jan. 5, 1918, or later, defendant purchased from plaintiff, by telephone, a car of "high-silicon iron," which was delivered. Defendant took exception to the quality of this car and it was resold to other parties by plaintiff. On Nov. 19, at time the first-mentioned car was contracted for, the parties entered into a written contract by which paintiff sold to defendant 850 tons of iron of various grades, to be delivered monthly over the first half of the year 1918. No iron was ever delivered under this contract.

These contracts were separate and independent of each other. The plaintiff being unable to get its pay for the first car delivered, it began this suit on April 17, 1918, to recover therefor and also to recover damages for defendant's failure to accept and pay for the car of "high-silicon iron." Defendant set off as damages plaintiff's failure to deliver iron under 850-ton contract. On trial the jury returned a verdict for plaintiff, $1,672.70, which was due on the car delivered and accepted, but refused to award defendant any damages on its matters of set-off. Defendant appealed its case.

Now, on the trial defendant conceded it owed plaintiff $1,672.70 for the car it accepted. The trial court held that plaintiff could not recover damages by defendant's refusal to accept the car of "high-silicon iron," because this was an oral contract, the order given by telephone, and involved more than $100 and was void under the statute of frauds. The only question to be decided by the Supreme Court was that relating to plaintiff's refusal to deliver iron under the 850-ton contract.

TIME OF DELIVERIES CONTINUED

This contract provided with reference to time of shipment: "Shipments: In about equal monthly quantities over the first half of 1918, buyer to give seller the quantity of each grade to be shipped on or before Dec. 1, 1917."

Very soon after making this contract, on Nov. 19, 1917, defendant ordered several cars of iron on the contract, notwithstanding it did not obligate the plaintiff to begin shipments until January. But defendant urged plaintiff to fill the order. Plaintiff advised that the terms of the contract would have to be changed from thirty days' time to ten-day drafts, subject to a discount of one-half of one per cent, applying to the whole contract. Defendant did not consent to this change until Jan. 4, 1918, and ordered three cars of No. 1 and No. 2 iron. It charged that plaintiff promised shipments would begin immediately if consent was given to the change in the terms, thereby waiving the time fixed in the contract for the shipments to begin. However, the order for three cars was subsequently countermanded or merged in an order for three cars on Jan. 25. The Supreme Court held plaintiff's failure to ship this last order placed it in default as to that, but it could not be liable on any of the previous transactions. And the jury failed to find any damages for this default.

Under the provision of the contract as to shipment, quoted above, the court held that plaintiff was under no obligation to begin shipments before Jan. 1, 1918, and that if it made shipment upon the last day of the month it was a compliance with the contract.

French Duties on Chemicals

The *Journal Officiel* of March 2, 1920, publishes a new status of chapters ex-XVIII (chemical products), ex-XIX (prepared dyes) and ex-XX (colors) with their coefficients of increase in specific rates of duties established in accordance with the new nomenclature specified by the law of Nov. 7, 1919, these new chapters being substituted for the corresponding ones in the table of coefficient increases as specified in the decree of July 8, 1919.—*The Review*, March 15, 1920.

Ozone in the Chemical Industries

By Chester H. Jones

WHILE a large amount of data has been published covering a number of installations where ozone is employed in air and water sterilization and purification, and while there has been considerable promotion propaganda using results of laboratory experiments with ozone in chemical applications, there has on the whole been little information available on commercial uses of ozone involving purely chemical reactions. It is known that a number of companies have purchased ozonators of the commercial type and are running them continuously in chemical plants, but definite information concerning their performance has been consistently withheld from publication.

Apparatus

There is now on the market a standard apparatus which is reliable as to both continuous operation and uniform output of ozonized air. Fig. 1 illustrates the three-tube laboratory unit and Fig. 2 a two-unit bank of six tubes per unit. The table herewith will show guaranteed output of this apparatus as listed from the three-tube laboratory type up to the ten-unit type consisting of six tubes per unit.

AIR FLOW AND OUTPUT OF SPRAGUE LABORATORY AND INDUSTRIAL OZONATORS

Number of Units		60 Cycles Grams O_3	60 Cycles Watts	60 Cycles Air per Hr. Cu.M.	60 Cycles Air per Hr. Cu.Ft.	133 Cycles Grams O_3	133 Cycles Watts	133 Cycles Air per Hr. Cu.M.	133 Cycles Air per Hr. Cu.Ft.
1	3-tube	2½	75	1	35	....	....	..	....
1	6-tube	6½	200	2½	90	13½	400	5	180
2	6-tube	13	400	5	180	27	800	10	360
3	6-tube	19½	600	7½	270	40½	1200	15	540
4	6-tube	26	800	10	360	54	1600	20	720
5	6-tube	32½	1000	12½	450	67½	2000	25	900
6	6-tube	39	1200	15	540	81	2400	30	1080
7	6-tube	45½	1400	17½	630	92½	2800	35	1260
8	6-tube	52	1600	20	720	108	3200	40	1440
9	6-tube	58½	1800	22½	810	121½	3600	45	1620
10	6-tube	65	2000	25	900	135	4000	50	1800

Maximum concentration:
3-tube, 2.5 g. per cu.m.
6-tube, 2.6 g. on 60 cycles, 2.7 g. on 133 cycles.

The general type of tube that is employed in the construction of these ozonators is illustrated in Fig. 3. Alternating electric current for the operation of this machine is first led to a transformer, where it is stepped up to a voltage of about 10,000 to 12,000. One of the transformer leads is then brought to the busbar of the machine and the other to the frame, so that a complete circuit may be traced from the transformers through the inner cylinder, across the air gap, and through the glass tube which forms the dielectric to the copper plating on the outside of the glass tube, which is in turn grounded to the frame and then back through return leads.

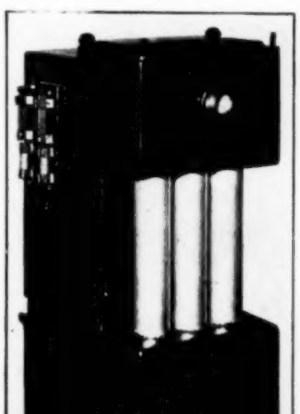


FIG. 1. STUBE OZONATOR

As the high-voltage current passes through the air gap, it does so in the form of a brush discharge which forms a purple ring completely filling the annular opening. This is not a spark, but a true so-called "silent discharge," although as a matter of fact it is accompanied by a rushing sound.

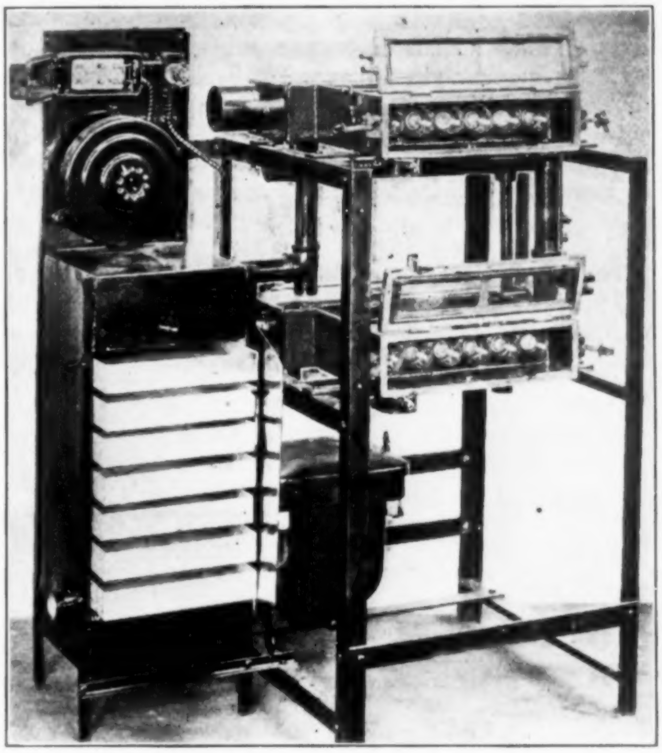


FIG. 2. A TWO-UNIT BANK OZONATOR, FOR OPERATION ON 110- AND 220-V., 60-CYCLE A.C.-OPEN

The copper tube which is shown surrounding the glass tube is employed for the protection of the glass, and while entirely non-essential as far as the operation of the machine is concerned, it is of great practical importance, preventing the frequent breakages and shutdowns which would occur in case the glass surface were left exposed.

The water shown surrounding the tubes is employed for the purpose of keeping down the temperature, which becomes quite high when the machine is in operation. As will be seen in this type of ozonator, the generating tubes are mounted in a casing so formed as to provide a chamber at each end of the open tube. Air is admitted under light pressure or subject to suction into the chambers at one end of the tube, and passes through the brush discharge and the annular space between the inner and outer electrodes. Passing through this discharge a portion of the oxygen in the air becomes ozonized and this ozonated air is conducted through piping to the point of application.

Referring to Fig. 2, trays with a wire gauze bottom shown are filled with a layer of calcium chloride. All the air going into the generating tubes is passed through the calcium chloride, thus giving a dry air and insuring successful operation of the ozonators.

The actual amount of ozone that can be generated in a tube of this kind is nearly proportional to two factors, namely, the voltage and the frequency of the electric current forming the discharge. Actual determination of these factors has been arrived at by observation rather than by any theoretical basis. The most practical limit of voltage has been found to be from 10,000 to 12,000 volts, the limitation being caused by the difficulty of securing adequate insulation when this limit is exceeded. With this voltage as a maximum,

most of the small outfits are operated at a frequency of sixty cycles, which is now standard central station supply. On medium-sized plants 133 cycles is often used, thus securing the double output from each tube. Up to now the highest frequency found in practical use in the largest installations is 500 cycles, which is employed in European countries and to some extent here.

Wax Bleaching

The Theodore Leonard Wax Co., of Haledon, N. J., has installed a twelve-tube unit industrial ozonator with a capacity of 12.5 g. per hr., and operates it continuously for the bleaching of wax, as shown in outline

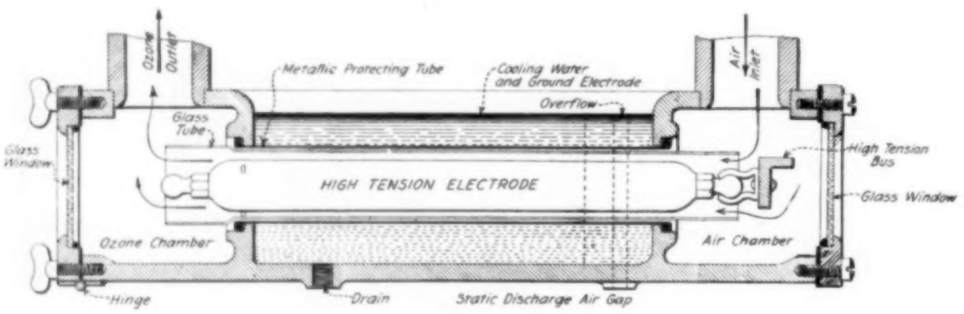


FIG. 3. SECTIONAL VIEW INDUSTRIAL OZONATOR TUBE

in Fig. 5. It will be noted that the air is forced through the ozonators and the ozonized product bubbles through about a 25-lb. (11.3-kg.) charge of wax contained in the tub. This charge of wax is kept molten by steam pipe introduced in a single turn through the tub. When ozone is passed at the rate of 12½ g. per hr., a charge of wax is bleached in a period of 4 to 5 hr.

Bleaching Textiles, Fabrics, Etc.

While considerable industrial work has been done along these lines, it has been surrounded with so much secrecy that definite data on installations are not available. Some knowledge of the research work done, however, should be of value.

In the bleaching of textile fibers and textures, a series of operations, the object of which is not only to decolorize the fibers but also to bleach them of any foreign substances, is performed. The bleaching or decolorization comprises the destruction of the natural colorizing matters or of the accidental colorizing matters which may be attached to the fibers through direct or indirect oxidation phenomena. To obtain this decolorization the oxygen of the air, chlorine in its different states, chlorate, bichromate, permanganate or ferricyanide of potassium and barium peroxide are used. For instance, the product called "ozonine," commonly employed in bleaching, is possibly composed of about 125 parts of resin, 200 parts of turpentine oil, 25 parts of hydrate of potassium which is dissolved in 40 parts of water, and 90 parts of ozonized water. Ozonized water in turn could be replaced by peroxide, such as peroxide of sodium.

At first the bleaching of textile fibers was obtained by exposure to the air. In this action oxygen, or better, ozone, oxidizes the colorizing matters and makes them soluble in a dilute alkaline solution. This bleaching, obtained by air or even by ozonized air, requires the action of solar light, according to A. and P. Buisine. If textile fibers are subjected to the action of ozone alone for a certain length of time, that is, until the bleaching obtained is satisfactory, the fibers become fragile and their resistance to wear is lessened to a large degree.

If, on the contrary, instead of ozone artificially obtained, chloride of lime alone is used, the bleaching obtained is insufficient, but the strength of the fibers is less affected than by ozone.

Bleaching by ozone alone takes place at a regular rate, but at a certain period the decolorizing action decreases and at the same time destruction of fiber becomes imminent. The moment at which bleaching is sufficient is consequently to be carefully watched and the action of ozone is then to be promptly stopped. If at this period the fibers are immediately put into a weak solution of chloride of lime, bleaching begins again. This action increases with a greater intensity than that by the use of chloride of lime alone.

Perfect bleaching of textile fibers can therefore be rapidly produced by using short ozonizations, followed by weak solutions of chloride of lime, without having to make use of slow bleaching by exposing on a flat surface. After this treatment the fibers are found to have kept their primitive strength.

From observations made by M. Frohlich, the Siemens and Halske Societies and the Freiffenberger Bleich-u.-Appretur Anstalt, it has been possible to bleach textile fibers satisfactorily by the combined action of ozone and of chloride of lime. Usually gray threads or yarns, after

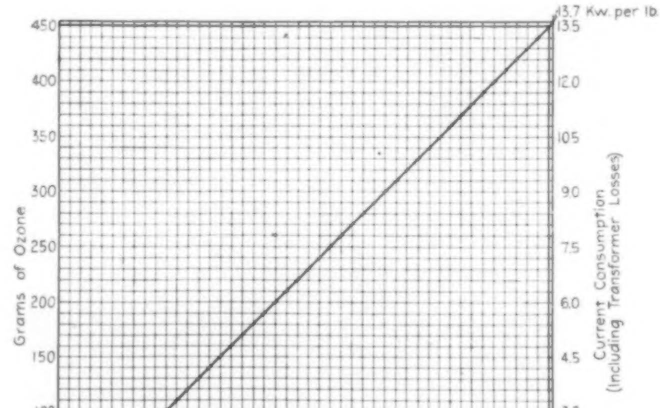


FIG. 4. CHART SHOWING COST OF MAKING OZONE

they have been prepared according to the usual methods by boiling in a washing bath of soda, are simply immersed in a concentrated solution of chloride of lime, removed and exposed to ozone and again placed for a few hours in a weak solution of chloride of lime. On being removed from the latter the fibers are rinsed, partly dried and placed again in the ozone room in a damp state. By this process the strength of the agents of bleaching is gradually diminished. The operations are performed in succession and repeated until the required degree of bleaching is obtained.

The ozone room must be constructed in such a way as to have all the parts of the yarns or threads submitted in turn and uniformly to light. Light of arc lamps can be used for this purpose. Currents of ozone must also act successively and uniformly on all the parts of the fibers. To obtain this result ozone must come into the room through as many apertures as possible, disposed in a uniform manner, which is effected by the use of perforated pipe protected by shellac or paraffine. In addition to this the textile fibers must be kept in motion so as to have their various parts placed under the action of ozone. This result can be obtained by means of a drum-shaped apparatus which is made to rotate and on which the fibers are placed.

If, after having prepared fibers according to the usual method, textiles are immersed in certain weak solutions of ammonia, of turpentine and ammonia emulsion, of turpentine essences, of soap or resin and ammonia, or of commercial indigo, and subsequently placed under the action of ozone, white fumes of aid to the bleaching process are formed. These fumes, the result of the oxidation of the substances with which the fibers are impregnated, in addition to compounds formed on

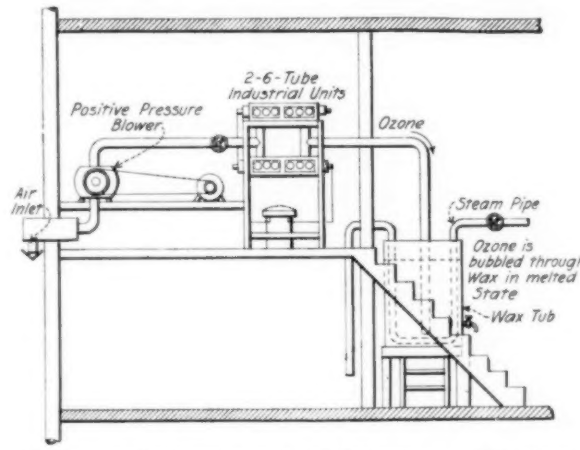


FIG. 5. OZONATOR FOR BLEACHING BEESWAX

the texture itself, facilitate the oxidation when placed in a slightly acidified bleaching bath.

Usually the textile substances under process after having been prepared in the usual way are immersed in solutions made of the chemical products enumerated above. After this operation they are taken out and partly dried, when they are placed in the ozone room for a certain length of time, then immersed in weak solutions of chloride of lime, partly dried and again placed in the ozone room. During these operations the effects of the bleaching are watched and the operations stopped at the proper point. Usually two rooms are used for the treatment and ozone is alternately introduced at intervals of a half hour. This saves loss of time and permits ozone to act gradually.

Bleaching by ozone is more or less rapid according to the nature and the condition of the fiber to be treated. It is economical of time and results in superior bleaching than that obtained by the old process of spreading textiles in the sunlight. The consumption of ozone is also variable according to the nature, the condition, the time of exposure, and also the volume of textiles to be treated, as well as according to the chemical substances which are used in conjunction.

Flax, hemp, jute, cotton, paper pastes, etc., can be bleached in a similar manner.

Flax texture is first placed in a mixture containing 15 g. of caustic soda at 36 deg. Bé. and 15 g. of ozonized oil per liter. After this has been boiled for 12 hr. the texture is washed and passed into neutralizing acid, and finally rinsed with clear water. A bleaching bath (peroxide of sodium) is then prepared. It is composed of the following formula:

Water, liters	1,000
Ozonized oil, kg	5
Peroxide of sodium, kg	7.5
Sulphuric acid, 60 deg., kg	10

This bath is made alkaline, and after the flax has been immersed it is heated to 80 or 90 deg. C. The bath is properly agitated during this treatment and at the end of 4 hr. the textures are taken out, washed, passed into acid and finally rinsed. The operation is continued until the desired bleaching result is obtained.

Bleaching Paper Pulp

Ozone is said to produce excellent results on paper pastes. The bleaching is not only perfect, but rapid and economical. It is said that the use of anti-chlorine such as hyposulphite of soda and nitrate of soda as used in the present processes may be avoided. Usually a current of ozone is sent through the bath of chloride of lime in which the paper paste is being bleached. This increases the action of the chloride and reduces the quantity used.

Sponge Bleaching

In the bleaching of sponges the raw sponge is first soaked in a solution of sulphuric acid to loosen the dirt and organic coloring matter. After wringing out the water, the damp sponge is placed in a strong ozone atmosphere, approximately 3 to 4 g. per cu.m. for a period of 3 to 7 hr., the time required depending upon the kind of sponge and not the size.

After a pale light-colored bleach is obtained, the sponge is rinsed in a solution of sodium carbonate to remove the free oxidized coloring matter and to neutralize the nitric acid formed during the treatment. This alkaline bath darkens the sponge somewhat to a canary yellow and its action is checked and tempered by again rinsing in a weak sulphuric acid solution followed by a thorough washing in plain water to remove all the chemicals and to secure a neutral condition.

A commercial plant along these lines was put in operation during the war when the price of the more usual reagent, potassium permanganate, was high, a two-unit 500-cycle plant being employed. This was discontinued, however, simultaneously with the drop in the permanganate market.

Drying Varnishes and Paints

The so-called drying of paint oil, such as linseed, is not caused by evaporation, but by oxidation, and when driers are mixed with paints or oils they are used simply to hasten this oxidation. By producing a partial oxidation of the oil before it is applied the drying is greatly hastened and more thoroughly accomplished and the process may even be continued after application by drying in the presence of ozonized air.

On examining a coating of oil paint on any surface it is found that the surface hardens over in a thin skin which shuts out the air from the lower layers and often requires a long time for the hardening to become deep seated and completed. If, on the other hand, the paint is treated with ozone previous to application, the ozone will apparently cause the oxidation to occur throughout

the entire thickness of the layer and a more thorough drying is thus secured.

An application of these ideas is shown in Fig. 6, giving a layout at the Heinze Electric Co., Lowell, Mass., where ozone is introduced into the drying ovens containing automobile magnetos. The armatures, after being wound, are subjected to impregnation with oil under vacuum. The oil thoroughly penetrates the windings, but when dried it hardens on the surface, leaving the interior in a soft condition. When magnetos are

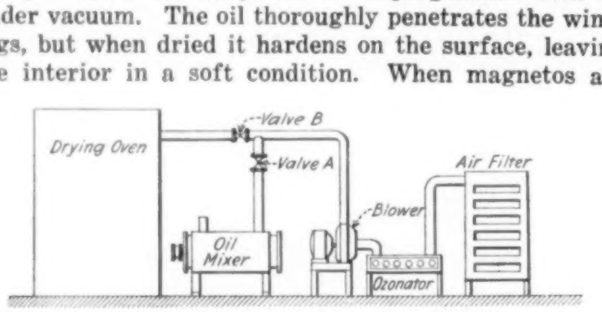


FIG. 6. PAINT DRYING APPARATUS

operated the armature is run at high speed and the centrifugal force is often sufficient to throw off this soft oil, thus spoiling the impregnation of the winding. This is remedied by ozonizing the oil before using.

The oil is first placed in a mixer where it is stirred up by a dasher, while the stream of ozonized air passes through the mixer and is brought into intimate contact with the oil by which the ozone is absorbed. After a few hours the oil is so charged with ozone that it may then be applied to the armatures with the certainty of its hardening thoroughly throughout. The armatures are then dried in the ovens, shown at the left of the sketch, which are also charged with ozone to hasten and improve the surface drying. Several musical instrument manufacturers have installed ozonator systems for furnishing ozonized air to drying rooms; Fig. 7 shows the layout at the Schubert Piano Co.

Since ozone oxidizes with enormously greater speed than oxygen, its value in paint and varnish drying is evident. In the painting of automobile bodies hurried drying is demanded by the crowded condition of the factories. Recent tests with ozonized air showed after 2 hr. an increase in weight of the painted body of 3.34 per cent, while with ordinary air the corresponding increase was only 1.51 per cent. This increase was due to the absorbed oxygen and fairly measures the relative rapidity of the two drying methods.

Oil Oxidation

Little data are available on the subject of oil oxidation. It is known that the Standard Oil Co. is making experimental tests with laboratory equipment, while some of the vegetable and animal oil producers are proceeding in like manner. There is every reason to believe that this will eventually be one of the largest fields for the employment of ozone. Oil may be completely solidified by treatment extending over a period of about three weeks, and the gummed oil, after it has been ground, is used in the manufacture of linoleum. Cottonseed oil may also be decolorized by the use of ozone.

For treatment of linseed and similar oils for bleaching, bodying and solidifying, the practice at present is to allow ozone, $\frac{1}{2}$ g. per liter per hr.; air, $\frac{1}{2}$ cu.m. per liter per hr. The oil should be treated in a mixer in which it is continually agitated by revolving paddles. Simply bubbling the ozone through the oil is not satisfactory and requires a much longer time for similar results.

Rapidity of thickening depends upon the temperature in which the oil is treated. Raw oil when run at 65 to 90 deg. C. thickens rapidly, solidification being secured in 6 to 8 hr., but the oil becomes darkened. When run at temperatures below 40 deg. C., the thickening proceeds more slowly (8 to 10 hr. for solidification), but the oil is bleached.

For bodying paint or varnish a run of 6 hr. is usually sufficient. For linoleum the average run for solidification is 8 to 10 hr.

Cold Storage Application

Ozonators have a wide use in the deodorizing and purification of air for cold storage chambers. While the activities of the bacteria which cause decay and mold growth in food materials are very largely checked by keeping the surrounding air properly dried and near the freezing point, the addition of ozone to destroy the odor carried in the air has achieved remarkable results. It furnishes a means of purifying the air of the storage room without ventilation and consequent loss of refrigeration required to cool newly admitted air. Thus, it is claimed that eggs in cold storage will

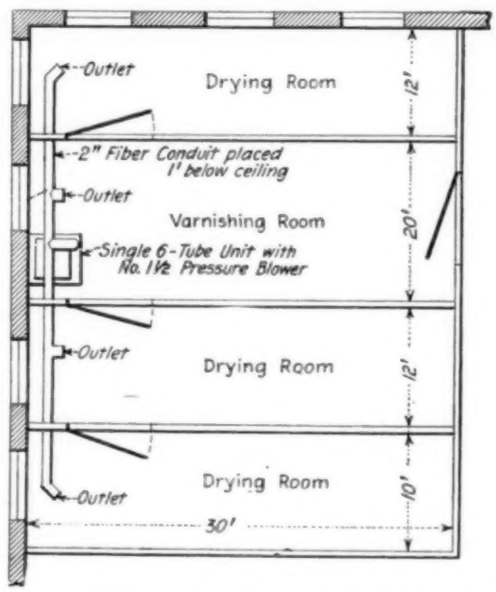


FIG. 7. OZONATOR FOR DRYING VARNISH ON PIANO CASES

carry much better in ozonized air. Not only is the average quality of eggs taken out much better, but if there are any cracked eggs in the cases, the cracks, instead of becoming moldy, will be dried up just as if they had been exposed to sunlight and air.

Future Developments

The future outlook for the use of ozone in the chemical application is promising. Ozonized air of high ozone content is available in such quantities as to permit commercial employment in the oxidation of the more rare organic chemical processes. Where larger quantities are required, a solution is suggested by the statement of Georges Claude that liquid oxygen at low temperatures is easily transformed by efflux into ozone.

Large plants exist in this country capable of producing oxygen at a few cents per thousand cubic feet. It requires no great imagination to see gaseous ozone produced from simple mechanical apparatus in the near future. Ozone thus cheaply prepared for the market opens up unlimited possibilities in chemical industries.

Report on Test of New Brunswick Oil Shales in the Wallace Retort

THE summary report of the Mines Branch of the Department of Mines of the Dominion of Canada for the year 1918 contains a report on the test of New Brunswick oil shales in the Wallace retort, together with a description of the Wallace retort, from which the following is abstracted:

Description of Retort

The new type of retort for the carbonization of coal and retorting of oil bearing shales is the invention of W. G. Wallace, superintendent of the St. Claire Gas Co., of East St. Louis, Mo. The essential idea of the retort is that of removing the volatile products without subjecting them to a temperature higher than that at which they are liberated from the shale. The design is illustrated in detail in Fig. 1. The distilling chamber *A* is cylindrical in cross-section and of less diameter at the upper than at the lower end, this chamber being surrounded by a circular combustion chamber *B*. A perforated take-off duct *C* is centrally located, the products of distillation being removed at the bottom through the pipe 2. The pipe 2 can be disconnected from the outlet of the take-off duct, permitting the bottom of the distilling chamber together with the perforated takeoff duct to be removed downwardly for the removal of the retorted shale. The perforated take-off duct is preferably of uniform circular cross-section, so that the annular space between it and the wall of the distilling chamber will diminish gradually in area from the lower to the upper end, thereby causing a uniform distribution of heat through the material within the annular space. This design of retort causes the products of distillation to pass through the cool material away from the heated wall of the retort, and thus materially aids in preventing the formation of unsaturated hydrocarbons which are produced at high temperatures and formed to a greater or less extent in usual types of retorts, where the products of distillation are brought into contact with the heated walls or the heated material within the retort from which the volatile products have already been removed.

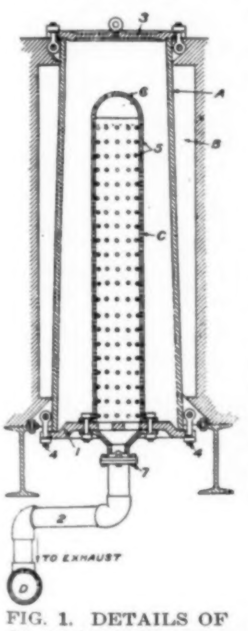


FIG. 1. DETAILS OF WALLACE RETORT

This design secures the advantages of low-temperature distillation in that the volatile products are given off at a minimum temperature, immediately cooled and removed from the influence of heat. It is further claimed that this method of distillation produces a larger yield of oils due to the fact that the vapors are not subject to excessive heating which causes the breaking up of the oils into permanent gases.

Tests on New Brunswick Oil Shale

The shale was taken from an opening on seam 1, Frederick Brook, Alberta mines, and represented a fair average of the seam, which was 4½ ft. in width. Two tests were conducted, the samples weighing 81 5/16 and 80 lb. each, the shale being crushed to ½-in. size.

Test No. 1. Before charging with the shale, the retort was brought to a cherry-red heat, while the temperature of the combustion chamber was 1,450 deg. F. (787 deg. C.). Pyrometers were placed in the combustion chamber, in the retort between the outside walls and take-off duct, and in the bottom of the eduction pipe. and the temperatures throughout this run were recorded at these points, at 15-min. intervals. The results are shown in Table I, together with the quantity of oil and gas recovered during these periods. The oil recovered contained a small quantity of water which was not determined.

TABLE I. RESULTS OF TEST NO. 1

Time	Temp. Combustion Chamber, Deg. F.	Temp. Retort, Deg. F.	Temp. Reduction Pipe, Deg. F.	Cu.Ft. Gas	Weight of Oil, Lb.	Oz.
9:20 a.m.	1,480	...	1,100	..	..	..5
9:35 a.m.	1,480	240	600	30	2	11
9:50 a.m.	1,490	280	500	50	2	6
10:05 a.m.	1,510	510	540	20	2	7
10:20 a.m.	1,520	620	650	25	2	6
10:35 a.m.	1,540	720	700	25	2	3
10:50 a.m.	1,530	820	810	25	1	.

Summary of Results

		Per Ton of Shale
Shale charged	81 lb., 5 oz.	....
Oil recovered	13 lb., 6 oz.	43 U. S. gal.
Gas	175 cu.ft.	4,290 cu.ft.
Spent shale	52 lb., 15 oz.	1,297 lb.

TABLE II. RESULTS OF TEST NO. 2

Time	Temp. Combustion Chamber, Deg. F.	Temp. Off-Take Duct, Deg. F.	Quantity of Oil, Lb.	Oz.
11:25 a.m.	1,360	740	..	..
11:40 a.m.	1,400	330	..	14
11:58 a.m.	1,410	400	1	3
12:10 p.m.	1,420	510	1	8
12:25 p.m.	1,430	630	2	1
12:40 p.m.	1,440	710	2	6
12:55 p.m.	1,450	800	2	3
1:10 p.m.	1,460	900	1	8
			0	3

Summary of Results

		Per Ton of Shale
Shale charged	80 lb.	....
Oil recovered	11 lb., 14 oz.	39.6 U.S. gal.

Test No. 2. The temperatures of the combustion chamber and retort before charging were considerably lower than that which obtained for the first test, consequently the yield of oil at the end of the first 15-min. period was less. The temperature of the combustion

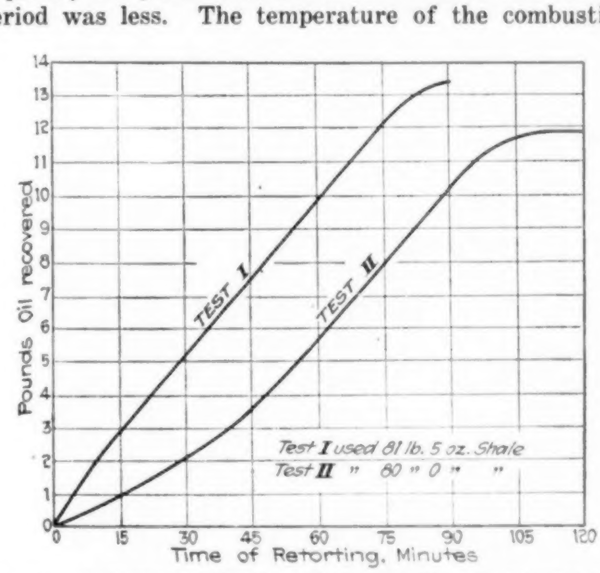


FIG. 2. CURVES SHOWING AMOUNTS OF OIL DISTILLED AT 15-MIN. INTERVALS

chamber and of the take-off duct were recorded and no record was made of the gas produced, since an air leak developed during the run. The results are given in Table II. The yield of oil of both tests are plotted against the time of distillation in Fig. 2.

Analysis and Results of Test of Sample of Oil Shale Sent to Fuel Testing Station

In order to check the results obtained with the Wallace retort, a general sample representing the entire quantity of shale retorted, and a sample of the spent shale were tested in the laboratories of the Fuel Testing Station. The results are given in Table III.

TABLE III. RESULTS OF CHECK TEST ON SAMPLE OF SPENT SHALE IN THE LABORATORIES OF THE FUEL TESTING STATION

Analysis:	As Received	Dried at 105 Deg. C.
Moisture	0.9	....
Ash	61.1	61.6
Volatile matter	33.9	34.2
Nitrogen	0.9	0.9
Distillations	**No. 1 Without Steam 740 Deg. C.**	**No. 2 With Steam 550 Deg. C.**
Yield of crude oil, per 2,000 lb. charged, U. S. gal	42	47
Yield of completely dried oil per 2,000 lb. charged, U. S. gal	37.6	37.3
Specific gravity, completely dried oil	0.87	0.89
Yield of gas per 2,000 lb. charged, cu. ft	3,700	3,540
Composition of gas:		
Carbon dioxide	25.1	31.0
Illuminants	2.5	2.6
Oxygen	0.2	0.5
Carbon monoxide	19.8	5.2
Methane	24.6	23.2
Hydrogen	21.7	32.6
Nitrogen	6.1	5.1
Calorific value, B.t.u. per cu.ft	380.0	351.C
Yield of ammonium sulphate per 2,000 lb. charged, lb.	16.0	19.0
Nitrogen in residue, per cent	0.5	0.7
Distribution of nitrogen from charge:		
In ammonia, per cent	21.0	24.0
In residue, per cent	42.0	58.0
In gas and unaccounted for, per cent	37.0	18.0
SAMPLE OF SPENT SHALE FROM WALLACE RETORT		
Nitrogen, per cent	0.5	....

The results obtained with the Wallace retort check remarkably well with that obtained with the retort employed in the laboratories of the Fuel Testing Station, especially since the maximum quality of oil is extracted by the laboratory retort.

Enamel Investigations at the Bureau of Standards

THE jumping off of small particles of enamel which results in the defect known in shop practice as "fish scaling" is probably the most serious defect to which enamels for sheet steel are subjected. It occurs intermittently in practically all the plants manufacturing this class of material in this country and entails losses running into millions of dollars to the manufacturers. At the request of the Metalware Manufacturers Association of America, the Enameled Metal Division of the American Ceramic Society and a large number of individual manufacturers, the Bureau is carrying on a comprehensive research in an endeavor to discover the cause or causes of this defect and the methods of controlling and eliminating it. This investigation was begun in July, 1919, and has been conducted energetically ever since.

Causes of Fish Scaling

Up to the present time, the Bureau has made ninety melts of enamel composed of twenty-one different compositions. These have been subjected to various treatments in firing and melting and have been applied in various ways to several kinds of steel. In all, over 4,000 sample enameled plates have been made up to date. This work has demonstrated that one of the most important factors in the production of fish scaling is too severe heat treatment in the firing of the enamel. Excess heat treatment may consist of firing the enamel at too high a temperature or of holding the enamel in the furnace for too long a time at a given temperature. Other important factors are the composition of the enamel, the physical and chemical characteristics of the underlying metal, the method of melting the chemical mixtures used in making the enamels and the shape and weight of the metal pieces that are enameled. These various factors have been investigated to a certain extent in this work and will be studied more thoroughly as the investigation progresses.

The data obtained in this investigation up to the present time have enabled the Bureau to be of very material assistance to several manufacturers in eliminating this trouble. It seems very probable that the completion of the investigation as now planned will definitely eliminate fish scaling, and likewise settle the interesting question of what is the physical basis of the phenomenon.

Acid-Resisting Enamels

For several months the Bureau has had in progress an investigation of the relation of composition of enamel to solubility in strong mineral acids. The need for this investigation was clearly demonstrated during the war by the difficulty manufacturers of acid-resisting enameled wares experienced in meeting the requirements of chemical manufacturing plants. The manufacturers of enameled kitchen wares are also interested in this problem.

Up to the present time thirty-three enamel compositions have been melted and tested. While the problem is a large one and the investigational work will necessarily be continued for some time, results so far obtained indicate that some of the commonly accepted conceptions of the relation between composition and acid resistance of enamels are erroneous. The chief of these misconceptions seems to be that oxides which are similar in nature chemically will have similar effects when incorporated in enamel compositions. That this is not always true is shown by the fact that calcium oxide tends to produce enamels with very low resistance to attack of acids while barium oxide produces quite resistant enamels.

Expected Results From the Investigations

In connection with the gathering of data on the chief object of this investigation, information is being secured in regard to relations of composition to their fusibility and to the tendency to chip or to craze, or crack. It is expected that as a result of this investigation the Bureau will be able to advise manufacturers of acid-resisting wares as to the methods of compositions to be used in producing wares of this class superior to any now being made, and also that it will enable the Bureau to be of material assistance to manufacturers of enameled ware for culinary purposes. As a matter of interest, it may be stated that as a part of this investigation an enamel has been produced which appears to duplicate in composition and working properties the best grade of French acid-resisting enamel.

Synopsis of Recent Chemical & Metallurgical Literature

Manufacture of Methylethylketone From Normal Butyl Alcohol.—Early in 1917, British Acetones, Ltd., began to produce acetone and normal butyl alcohol in large quantities by the fermentation of carbohydrate material in the presence of certain micro-organisms. There was at that time an almost unlimited demand for acetone, but the disposal of the rapidly accumulating stocks of normal butyl alcohol was a different proposition. No commercial demand had been developed and an attempt to substitute it for ethyl alcohol as a solvent in the manufacture of smokeless powder had failed. How this problem was solved is told by T. C. NEWMAN in the *Canadian Chemical Journal*, February, 1920, p. 47.

Under the direction of D. A. Legge, a process was developed for the conversion of the alcohol into methylethylketone (methylacetone) or M.E.K., as it was called in the plant. This product was accepted by the British Government as a cordite solvent and was used under the name of "cordite ketone."

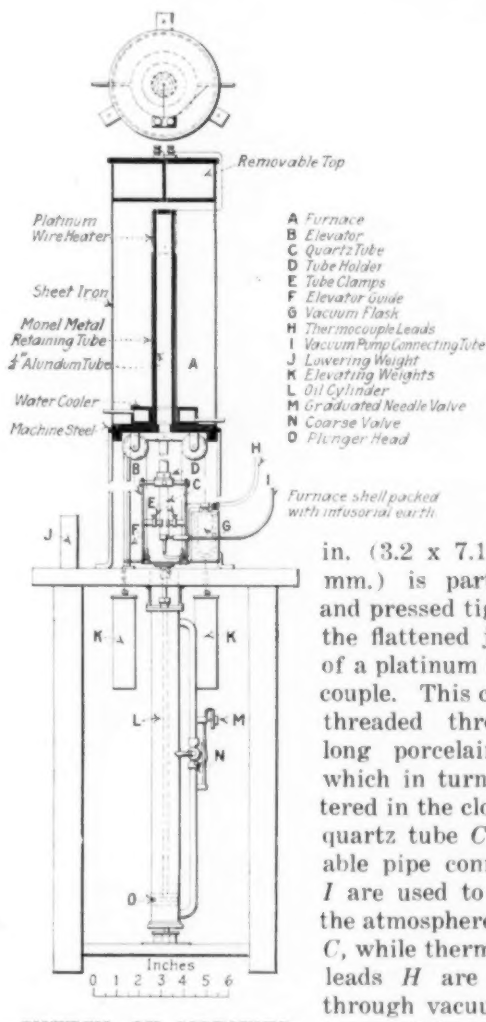
The theory of the process will be found in organic text books. The normal butyl alcohol is dehydrated, forming butylene, which treated with hydriodic acid yields β-iodo-normal-butane. This is converted into secondary butyl alcohol by heating with wet silver oxide. The secondary alcohol is then dehydrogenated, yielding methylethylketone. Of course, this is suited to the laboratory, but for a plant handling 25,000 lb. per day, substitutes for hydrogen iodide and silver oxide had to be found. In practice, sulphuric acid and water were used.

Butylene was prepared by passing the vapors of the normal butyl alcohol over heated kaolin. The temperatures required were markedly lower than those used in the preparation of ethylene from ethyl alcohol. The catalyzers were made up in batteries of three small units, each unit being held 40 deg. C. higher in temperature than the previous unit. The hot vapors from the catalyzers were passed through a gas cooler and gas separator. The butylene was then liquefied by an ordinary ammonia compressor and stored in high pressure storage tanks. The liquid butylene was pumped to a sulphating kettle, where it was treated with 60 per cent sulphuric acid. This reaction is extremely exothermic and is the most difficult step in the process. During the experimental stages there was a tendency for dibutylether to form, but this was overcome by details of plant operation.

The butylene hydrogen sulphate was diluted and distilled, forming secondary butyl alcohol with simultaneous regeneration of the sulphuric acid. The latter was reconcentrated in two 30-ton units. The secondary butyl alcohol was redistilled to free it from water and then passed through a second series of catalyzers similar in design to the first, in which it was dehydrogenated. Certain metallic oxides served as the catalyst. After condensation and separation from the hydrogen, the crude methylethylketone was distilled, yielding on a single distillation a very pure product containing as its only impurity slight traces of the pinacone.

Since the war the problem has been solved in a different manner through the production of butyl acetate, which is rapidly replacing amyl acetate as a nitrocellulose solvent. There are several reasons for this: The butyl alcohol is extremely pure, 90 to 95 per cent of it distilling within 0.5 deg. C. of the true boiling point; the odor of butyl acetate is not nearly so oppressive as that of amyl acetate; its technical effect is just as good; it is much cheaper in price.

Modified Rosenhain Furnace.—H. SCOTT and J. R. FREEMAN of the Bureau of Standards describe a perfected furnace for thermal analysis in Bulletin 152 of the American Institute of Mining and Metallurgical Engineers, and in Scientific Paper No. 348, Bureau of Standards. A sketch of the furnace is annexed and is practically self-explanatory. A small sample, $\frac{1}{8}$ x $\frac{9}{32}$ x $\frac{1}{8}$ in. (3.2 x 7.15 x 3.2 mm.) is partly slit, and pressed tightly on the flattened junction of a platinum thermocouple. This couple is threaded through a long porcelain tube, which in turn is centered in the closed-end quartz tube *C*. Suitable pipe connections *I* are used to control the atmosphere within *C*, while thermocouple leads *H* are carried through vacuum flask *G* to a dial potentiometer. Steady current (5 amp. at 30 volts) passes through seventeen turns of 0.52-mm. platinum wire, wound around the top end of the $\frac{1}{4}$-in. walled alundum tube, and maintains the temperature of the top end continuously at something over 1,000 deg. C. The sample is gradually elevated to this heated region by means of gravity, weights *K* furnishing the motive power, regulated by oil by passing through needle valve *M*. Inverse-rate heating and cooling curves taken in this manner on transformationless steel (containing 28 per cent nickel) results in an almost geometric vertical between 250 and 1,000 deg. C.



SKETCH OF MODIFIED ROSENHAIN FURNACE FOR THERMAL ANALYSIS

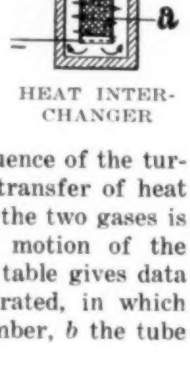
Recent Chemical & Metallurgical Patents

Complete specifications of any United States patents may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Benzoic Acid From Toluene.—A layer of toluene (100 lb.) is placed on the surface of about 250 lb. of 38 per cent HNO_3 in a suitable reaction vessel provided with a reflex condenser. After heating to about 90 deg. C., the reaction is started by adding 0.1 per cent paraformaldehyde. At the end of four or five days the reaction is complete and the upper layer of benzoic acid, benzaldehyde and toluene is removed and treated with alkali. The solution of sodium benzoate obtained may contain nitro compounds which may be removed by reduction to amino compounds. Benzoic acid is recovered by precipitation with an acid. It is claimed that the yield is nearly quantitative. The product is, of course, free from chloride. The process may also be applied to other oxidations of side-chains in aromatic compounds, such as the manufacture of orthonitrobenzoic acid from orthonitrotoluene. (1,332,028; VIRGIL COBLENTZ and HAROLD W. WALKER of New York, assignors to Commercial Research Co.; Feb. 24, 1920.)

Stopper.—WILLIAM M. GROSVENOR of New York has devised a stopper for use in connection with the distillation of inflammable volatile organic liquids. It is more permanent and efficient than the ordinary tinfoil-wrapped cork or rubber stopper. It consists of a short tube of block tin upon which a tapered rubber stopper is vulcanized. The rubber is protected with sheet tin about 0.015 in. thick, autogenously welded to the inner tube. (1,332,335; March 2, 1920.)

Heat Interchanger for Synthetic Ammonia Process.—The efficiency of the exchange of heat between incoming and outgoing gases in the Haber synthesis is increased by modifying the design of the interchanger in accordance with the principles set forth by Stanton and Pannel, *Philosophical Transactions,* A. 214, p 199; 1914. When the velocity of fluids exceeds a certain "critical velocity," turbulent motion (instead of stream line motion) is set up. The critical (mean linear) velocity is equal to a constant times the "kinematical viscosity" divided by the diameter of the tube. The "kinematical viscosity" is equal to the viscosity divided by the density. The constant is approximately equal to 2,500 for any fluid when dealing with smooth circular tubes and when using C. G. S. units. The "critical velocity" may be easily calculated provided that the density used corresponds to the pressure in the apparatus and that the value of the "kinematical viscosity" is taken for the temperature in question. In consequence of the turbulent motion of the fluid, the rate of transfer of heat across the separating partition between the two gases is very high, whereas with stream line motion of the fluid it is very low. The accompanying table gives data for an interchanger of the type illustrated, in which *a* is the electrically heated catalyst chamber, *b* the tube through which the incoming gases pass and *c* the tube for the outgoing gases.



HEAT INTERCHANGER

	Temp., Deg. C.	Pressure Atmospheres
Catalyst chamber	600	148
Inlet of *b*	20	150
Outlet of *b*	550	149
Inlet of *c*	600	148
Outlet of *c*	70	147

Diameter of tubes:
b—Internal, 2 in.; external, 2¼ in.
c—Internal, 3 in.

Volume of gas passing through the tubes 100,000 cu.ft. per hr., expressed as free hydrogen and nitrogen measured at 20 deg. C.

(1,329,397; HAROLD C. GREENWOOD of Putney, London, England; Feb. 3, 1920.)

Synthetic Production of Sodium Cyanide.—Molten metallic sodium and nitrogen gas are introduced simultaneously into an iron vessel filled with charcoal heated to about 800 deg. C. With 784 kg. of sodium and a slight excess over the theoretical equivalent of nitrogen, 96.7 kg. of NaCN drained from the charcoal while the balance of about 1,570 kg. was retained in the charcoal mass, the latter showing an average test of about 64 per cent NaCN. The NaCN can be leached out. (1,332,439; HANS FOERSTERLING, HERBERT PHILIPP and RALPH N. SARGENT of Perth Amboy, N. J., assignors to Roessler & Hasslacher Chemical Co.; March 2, 1920.)

Synthesis of Ammonia.—The yields in the Haber process for the production of ammonia from mixtures of nitrogen and hydrogen are increased by the use of pressures from 400 to 2,000 atmospheres as compared with pressures of 100 to 200 atmospheres used by Haber. GEORGES CLAUDE of Paris, France, has perfected an apparatus whereby these enormous pressures may be achieved in practice. The gas mixture is compressed in stages to 100, 350 and 1,000 atmospheres and is then led through heat interchangers in series in which the catalyst is placed. Owing to the high pressure, the ammonia formed may be liquefied by cooling with water between interchangers. The liquid ammonia is removed while the uncombined gases pass on to the next interchanger. When operating at 1,000 atmospheres, three interchangers in series will give a coefficient of combination of 50 per cent, whereas the Haber process does not exceed 11 to 15 per cent. The reaction is started by an electrically-heated coil, after which the heat of reaction maintains the required temperature of 500 to 700 deg. C. The nature of the catalyst is not disclosed, but it is stated that catalysts of low efficiency, such as iron, may be employed. [1,332,460; assigned to L'Air Liquide (Societé Anonyme Pour L'Etude et L'Exploitation des Procédés Georges Claude); March 2, 1920.]

Alumina. — Aluminum hydroxide is precipitated from solutions of aluminum salts (obtained from the treatment of labradorite) by heating with ammonia in an autoclave for about 8 hr. at 10 to 15 atmospheres. Precipitate formed in this manner settles readily and may be filtered by suction. The wet precipitate is now heated to a temperature between 100 and 200 deg. C. This treatment changes the precipitate from colloidal to powder form, so that the mass may be washed and filtered with ease. The filtrate may be used for the treatment of further quantities of labradorite by heating under pressure. Ammonia is evolved and the residue of aluminum silicate may be converted into a soluble aluminum salt by treatment with acid. (1,333,020; BIRGER F. HALVORSEN of Christiania, Norway; March 9. 1920.)

Current Events
in the Chemical and Metallurgical Industries

Industrial Conference Plan for Settling Labor Disputes

The Industrial Conference, appointed by the President last year to consider ways and means of preventing industrial disputes and settling differences between employers and employees, has made a final report. The machinery devised for the settlement of labor problems comprises a National Industrial Board, local Regional Conferences and Boards of Inquiry, functioning in the following manner:

1. The parties to the dispute may voluntarily submit their differences for settlement to a board, known as a Regional Adjustment Conference. This board consists of four representatives selected by the parties, and four others in their industry chosen by them and familiar with their problems. The board is presided over by a trained Government official, the regional chairman, who acts as a conciliator. If a unanimous agreement is reached, it results in a collective bargain having the same effect as if reached by joint organization in the shop.

2. If the Regional Conference fails to agree unanimously, the matter, with certain restrictions, goes, under the agreement of submission, to the National Industrial Board, unless the parties prefer the decision of an umpire selected by them.

No Interference With Production Pending Adjustment

3. The voluntary submission to a Regional Adjustment Conference carries with it an agreement by both parties that there shall be no interference with production pending the processes of adjustment.

4. If the parties, or either of them, refuse voluntarily to submit the dispute to the processes of the plan of adjustment, a Regional Board of Inquiry is formed by the regional chairman, of two employers and two employees from the industry, and not parties to the dispute. This board has the right, under proper safeguards, to subpœna witnesses and records, and the duty to publish its findings as a guide to public opinion. Either of the parties at conflict may join the Board of Inquiry on giving an undertaking that, so far as its side is concerned, it will agree to submit its contention to a Regional Adjustment Conference, and, if both join, a Regional Adjustment Conference is automatically created.

5. The National Industrial Board in Washington has general oversight of the working of the plan.

Plan Applicable to Public Utilities

6. The plan is applicable also to public utilities, but in such cases the Government agency having power to regulate the service has two representatives in the Adjustment Conference. Provision is made for prompt report of its findings to the rate regulating body.

The Conference makes no recommendation of a plan to cover steam railroads and other carriers, for which legislation has recently been enacted by Congress.

7. The plan provides machinery for prompt and fair adjustment of wages and working conditions of Government employees. It is especially necessary for this class of employees, who should not be permitted to strike.

Relies on Public Opinion

8. The plan involves no penalties other than those imposed by public opinion. It does not impose compulsory arbitration. It does not deny the right to strike.

It does not submit to arbitration the policy of the "closed" or "open" shop.

The plan is national in scope and operation, yet it is decentralized. It is different from anything in operation elsewhere. It is based upon American experience and is designed to meet American conditions. It employs no legal authority except the right of inquiry. Its basic idea is stimulation to settlement of differences by the parties in conflict, and the enlistment of public opinion toward enforcing that method of settlement.

American Association of Engineers' Convention

It has been decided that chapter representation at the sixth annual convention of the American Association of Engineers (St. Louis, May 10 and 11) will be in proportion to chapter membership. One chapter is entitled to one delegate or more, not to exceed one for each one hundred members. Each delegate is entitled to cast a number of votes equal to the number of certified and junior members in good standing in the chapter which he represents, but not to exceed 500 in all.

One of the subjects to be discussed is "The Reorganization of A. A. E. on a Business Basis." The suggestion has been made by W. W. K. Sparrow that the association employ a high-salaried paid president.

On the evening of the first day of the convention, Monday, May 10, there will be held seven group meetings for various groups of engineers. Among the subjects to be considered are:

"Getting Salary Schedules for Public Service Engineers Into Budgets," "What Part Shall A. A. E. Take in the Presidential Campaign?" "Making a Chapter a Force in the Community," "The Federal Department of A. A. E.," "Opportunities for the Engineer in Each of the Various Branches of the Profession," "Co-ordinating A. A. E. Activities in the State."

Senate Approves Sale of Sodium Nitrate

By accepting the House amendments to the bill providing for the distribution to fertilizer manufacturers and users of a portion of the Government's nitrate reserve the Senate eliminated all delay in the enactment of the legislation. The War Department opposed the House amendment until assured that it was the understanding of Congress that the funds derived from the sale of this nitrate would be available for the replacement of that portion of the nitrate reserve which might be used to meet the existing emergency.

War Department Defends Government Operation of Nitrate Plants

War Department officials appeared before the Senate Committee on Agriculture last week and presented arguments and data in reply to the contentions made by Frank S. Washburn of the American Cyanamid Co. The charges with which the War Department representatives took issue particularly were those to the effect that operation of the Muscle Shoals nitrate plant would be unfair to the Cyanamid company; that there would be no market for the products of the plant; that even if there were markets the products could be sold only at a loss; and that there would be no justification in reducing the stocks of sodium nitrate if the plant were operated. Issue also was taken with the recommendation by Mr. Washburn that construction work on the dam and power plant be stopped immediately; that the nitrate plant be put in standby condition ready for the production of ammonium nitrate in case of war; and that the Government hold itself in readiness to sell the plant to private interests should conditions justify.

Completion of Hydro-Electric Plant

The Secretary of War, who testified for the second time, expressed the opinion that work on the dam should be continued irrespective of whether the nitrate plant is operated or kept in standby. He based his statement on the general need of the country for additional electric power and the particular need of the section tributary to the Muscle Shoals water power. In addition he pointed out that $7,000,000 has already been expended on construction of the dam, all of which would be wasted if this project were to be abandoned. He emphasized the importance of operating the plant as a going concern in order to keep in touch with the developments in the fixation of nitrogen as well as to insure a trained organization which would form the nucleus for the expansion which would be necessary in case of an emergency.

Government Operation Does Not Violate Contract

Colonel Joyes in his testimony established that the proposal to operate this plant for the manufacture of nitrogen fertilizer materials was entirely in accordance with the present contracts in force between the Government and the American Cyanamid Co. and that there is no intention on the part of the Government of violating the contractual obligations with the company.

Replacement of Sodium Nitrate by Ammonium Sulphate

Major Gaillard testified again. He pointed out that sulphate of ammonia could replace, at least to the extent contemplated by this plant, nitrate of soda in fertilizers and instanced the fact that these two materials have sold and are selling on a competitive price basis. He brought out the relative prices of the two materials in mixed fertilizer in the past showing the steady increase in the use of sulphate as compared to nitrate.

Criticism of Production Costs

Major Gaillard also declared that Mr. Washburn's costs, which show no margin over and above operating expenses, were based on the use of steam power, which the Government did not contemplate using. He also claimed Mr. Washburn's figures contained other items not properly chargeable to operating costs. Even if Mr. Washburn's figures for the cost of production could be accepted, Major Gaillard declared, there still would be a margin of from $15 to $20 per ton of sulphate between the probable selling price and the cost of production.

Idleness Will Cause Deterioration

Colonel Burns, in an effort to disprove Mr. Washburn's contention that the plant would be just as available in case of a war emergency if kept in standby condition quoted from Mr. Washburn's testimony before the House Committee on Military Affairs in 1916 at which time Mr. Washburn stated that is was conceivable that plant of this sort could be maintained in idleness without such a degree of deterioration as to render it useless but that it was highly improbable that it would be so maintained and that a country which should rely for its powder supply upon the practically indefinite maintenance and working order of an idle plant would be taking a most extraordinary risk, which if it could be avoided, would be unwarranted and that a minor objection would be the cost of maintaing such a plant in readiness for operation, its upkeep and the interest on the idle capital. Colonel Burns reiterated that the operation of this plant would make it possible to redudce the reserve stock of Chilean nitrates by 150,000 long tons.

Availability of Ammonia Nitrogen

Dr. Milton Whitney, chief of the Bureau of Soils, testified as to the present urgent need in American agriculture of the products of this plant. He brought out the developments that must occur in the fertilizer industry in the use of inorganic nitrogen rather than of organic and of the more concentrated inorganic material. He stated that he entertained no doubt whatever that the products of this plant could be absorbed immediately in the agriculture of the country. He also called attention to the fact that while organic nitrogen, ammonia nitrogen, and nitrate nitrogen are somewhat different in their actions in the soil, that there is no such wide difference that would preclude the use of one material in the place of the other, in the absence of the other. He challanged Mr. Washburn's statement that ammonium sulphate cannot replace nitrate of soda in fertilizers.

Niagara District Industrial Association

There has recently been organized the Niagara District Industrial Association, embracing all the towns and cities of the Niagara Falls consular district and having for its object the promotion of industries in that section. With the rapid pushing forward of the hydro-electric canal and the completion of the Welland Ship Canal (on which work is soon to be resumed), an abundance of electric power and increased facilities for shipping will be made available here, and both points to a greater development of this already important industrial region. This district offers special opportunities to the following classes of industry: All manufactures of iron, steel, textiles, paper and pulp, electrochemicals, milling and refining.

It is in project to hold a three days' industrial congress in August next, for the purpose of bringing to the canal and power zone representatives of United States industries, in order to show them the advantages here in the way of power and of ocean-going transportation.

Canadian Institute of Chemistry

The Canadian Institute of Chemistry was organized last May at Montreal, and now has its headquarters at 314 Beaver Hall Hill in that city. The president is Prof. J. Watson Bain of the University of Toronto, and Harold J. Roast is secretary-treasurer. Among its objects are to develop the profession of chemistry so that trained chemists may become eligible for the growing needs of the country, to provide consultation for the requirements of the government, "to protect the public by gathering together a body of men who may be consulted with confidence," and to provide a registration bureau, social centers for chemists only and an employment bureau; also for the exchange of chemical knowledge by the organization of sections and sectional meetings.

Members are to be known as fellows and associate fellows, of whom the latter correspond to junior members, subject to approval by the council before their election to full fellowship. The requirements for fellowship are that the candidate

(*a*) be at least twenty-five years of age, a graduate of a recognized university having had a four years' course in pure or applied chemistry as his major subject, and who has been actively engaged in the pursuit of chemistry for two additional years in a responsible capacity.

(*b*) Under similar requirements in the main, if he has taken a three years' course he must show that he has had three years' additional experience in a responsible capacity in an approved laboratory.

(*c*) Lacking the requirements of (*a*) and (*b*), he must have held a position of responsibility in pure or applied chemistry for five years or more and will be examined as to his capacity by a committee of the Council. The examination may be waived in the discretion of the Council if the applicant has had eight years of such experience at the time of the inauguration of the Institute.

Associate fellowship provides for properly trained chemists under twenty-five years of age. At the last report the Institute had 113 fellows and three associate fellows, and it is announced by the secretary that "His Royal Highness, the Prince of Wales, has graciously consented to become an honorary fellow." In accordance with the British custom, fellows and associate fellows may add the letters F. C. I. C. or A. C. I. C. respectively after their names. Both men and women are eligible.

Bureau of Standards Appropriation

As finally agreed upon, the legislative, executive and judicial appropriation bill makes available to the Bureau of Standards $432,360 for salary accounts.

In addition, the bill provides $30,000 for testing varnish materials, soap materia's, inks and chemicals. Another item of $10,000 is given the Bureau for work looking to the development of color standards and color measurement, with special reference to their industrial use in standardization and specification of colorants, such as dyestuffs, inks and pigments, and in paint, paper and textiles in which color is a pertinent property. The sum of $25,000 is provided for the continuation of the investigation of the problems involved in the production of optical glass. An additional $25,000 is allowed for metallurgical research. This work includes the development of metal substitutes, as for platinum.

Phthalic Anhydride May Again Be Used as Synthetic Indigo Intermediate

A new importance is being placed upon the development during the war by the Bureau of Chemistry of a method for producing phthalic anhydride. The scarcity of wood and other causes is adding materially to the cost of methyl alcohol and formaldehyde. Due to the cheapness with which phthalic anhydride is being manufactured by the Bureau of Chemistry's process, it seems probable that it will be employed in the near future in the manufacture of indigo. The wood situation is more clearly reflected in the paper market. That this scarcity is likely to continue for an extended period is indicated by the fact that English interests have just purchased, for a large sum, the English rights to the public service patent which was secured by the Bureau of Chemistry for its process.

The Bureau of Chemistry during the war developed the method of production on a laboratory scale. The process resulted in a purer product than had been made in Germany. Through co-operation with private manufacturers the process has been made a commercial success, with the result that phthalic anhydride is being produced at decreasing costs and is even being sold at the very gates of Germany. Switzerland has been a recent large buyer of the anhydride in this country. Important shipments also have been made to England, Japan and other countries.

Phthalic anhydride formerly was used as an intermediate in the manufacture of indigo, but was displaced by the use of the cheaper process, which in turn seems about to be displaced as a result of the cheapness of the new process combined with the rise in price of alcohol.

Potash From Green Sands

The Eastern Potash Corporation of New York is building a plant to make potash and fertilizer from the green sands of New Jersey. These sands contain from 7 to 8 per cent of potash, and occur in large deposits in the states of New Jersey, Delaware, Maryland and Virginia.

Their plant is located on the Raritan River Canal near New Brunswick, and is accessible by both water and rail. It covers about eighty acres, and is designed to handle 1,000 tons of green sands a day and produce 20,000 tons of K_2O and 600,000 tons of residue per year. Connected with this plant is the largest lime plant in the world, containing ten 8 x 125 ft. rotary kilns, producing 1,000 tons of lime a day.

Limestone for this plant will be quarried from the company's quarries located in the northern part of the state, where it will be crushed and then shipped by rail to New Brunswick. The company also owns the entire capital stock of the Raritan Refining Corporation, a near-by company, which has a favorable contract to refine Mexican petroleum. The Eastern Potash Corporation will use the fuel oil from this company to operate its power plants and kilns.

A contract has also been let to build a brick plant to utilize the residue, which makes a fine lime silica building brick. Capacity of this plant is to be 500,000 brick per day, and it is so designed that it can readily be increased to 1,000,000 brick per day.

The New Brunswick plant is now about 60 per cent completed and it is expected to be in operation early next fall. The cost of the plant is estimated to be about $250,000.

Society of Cotton Products Analysts to Hold Convention

The eleventh annual convention of the Society of Cotton Products Analysts will be held at the Grunewald Hotel, New Orleans, La., on Monday and Tuesday, May 10 and 11.

Besides the many matters of importance that will come up, and a number of reports and discussions, the program will include the following:

L. M. Tolman, chief chemist, Wilson & Co., "Oriental Oils."

Eugene E. Ayres, Sharples Specialty Co., "Centrifugal Recovery of Cottonseed Oil From Soap Stock."

George S. Jamieson, chemist in charge Fat, Oil and Wax Laboratory, Bureau of Chemistry, "The Composition of Cottonseed Oil."

Dr. David Wesson, chief chemist, Southern Cotton Oil Co., "The Eastman Colorimeter"; "A New Optical Method for Determining Oil in the Mill Product."

Harrison E. Howe, vice-chairman, Division of Industrial Relations, National Research Council, "The National Research Council and Its Relation to Our Society."

I. G. Priest, physicist, Bureau of Standards, "Rainbow Report on Color of Vegetable Oils."

Three sessions will be held, the first early Monday afternoon and two sessions Tuesday. Tuesday evening a real round-table gathering, in the form of a subscription dinner at the Grunewald, has been arranged.

Civil Service Examinations

The following examinations are announced by the United States Civil Service Commission:

Expert Driller. A vacancy exists in the Bureau of Mines at a salary of $3,000 to $3,600 a year. At least six years' experience in oil and gas well drilling is required. Apply on Form 2118 before May 11.

Supervising Metallurgist. The duties of this position will be to take charge of one of the mining experiment stations of the Bureau of Mines. Salary, $4,000 to $5,000 a year. Apply on Form 2118 before May 25.

Laboratorian Qualified in Photography. Applicants must have had at least three years' experience in general photographic work, two years of which must have been in photomicrographic work. They must understand rudiments of metallography and be able to etch metals and photograph their microstructure. Vacancies exist in the Navy Department at $4 to $7.20 per day. Apply on Form 1312 before May 25.

Sixth Member Society of Engineering Council

The American Railway Engineering Association has accepted an invitation from United Engineering Society to become a member society of Engineering Council. The Association has about 1,650 members and its headquarters are at 431 South Dearborn St., Chicago, Ill. Its president is Harry R. Safford, and its secretary E. H. Fritch. The excellent technical work done by the committees of this Association in many branches of railroad construction and maintenance is well known. The Association has named as its representative upon Engineering Council its president, Mr. Safford, who is a member of the American Society of Civil Engineers and Engineering Institute of Canada.

The societies now represented in Engineering Council have an aggregate membership of 45,000.

Relieving the Freight Car Shortage

The Material Handling Machinery Manufacturers Association has made the following calculation to show how co-operation will assist in relieving the existing car shortage.

In the United States there are about 2,452,000 freight cars now in use. These are rolling in trains loaded and empty only 9.03 per cent of the time. They average 11.29 per cent time loading and 11.29 per cent being unloaded, if every car is released before demurrage starts. The balance of 68.39 per cent is waste time, due to repairs, switching and unnecessary delays. One hour saved each day for each car would equal 2,452,000 car-hours per day. Dividing this figure by 24 (hours per day,) it is self-evident that the public would have over 102,000 additional cars to use through this simple saving of one hour per car per day.

This may be accomplished if every person or company loading or unloading cars will explain to the crews doing the work that every car released quickly helps each maker or manufacturer to increase his ability to get his goods quicker and at less expense. This ultimately reduces living costs for the crews and all.

Offer to Lease Muscle Shoals Nitrate Plant

A new angle in the matter of whether Muscle Shoals plant should operate was introduced by the proposals of L. T. Layton, representing the Fisheries Products Co., a $10,000,000 corporation, when he appeared before the House of Representatives committee investigating expenditures in the War Department. Mr. Layton's company is considering negotiation of a lease of part or all of the Muscle Shoals plant, with the idea of adding these operations to the company's existing fertilizer manufacturing activities. At present its principal activity is in the field of fish scrap, which it has developed as a fertilizer material, most extensively through North Carolina, South Carolina and Georgia.

This definite proposal that one company is willing to make arrangements with the Government to lease or perhaps purchase this plant seems in conflict with the claims which have been made recently that there is no available market for it or its products.

Stumpage for Tannin Extract for Sale

Plans are being made by the District Forester in Washington for the sale of approximately 150,000 cords of chestnut tannin extract wood stumpage in the Nantahala National Forest, in western North Carolina. The timber lies in Macon county along the Nantahala River and about fifteen miles distant from Andrews. Franklin is about the same distance to the east.

On privately owned land adjacent to this body of Government timber there is estimated to be approximately 200,000 cords of chestnut. This, in connection with the timber to be sold by the Forest Service, would be sufficient to maintain a moderate-sized tannic-acid plant for twenty-five years. Approximately 15,000 acres of Government lands are involved, of which 10,500 are heavily timbered.

The topography is favorable for all lumbering operations and work may be carried on practically throughout the year. A privately owned standard-gage railroad parallels the tract for some distance. Sufficient labor to operate a moderate-sized plant is said to be available from local sources.

A Few Uses of Zinc and Zinc Compounds

The inter-departmental committee of the Bureau of Standards at Washington has adopted new specifications for paint to be purchased by the Government that provide for not less than 30 per cent of zinc oxide in the pigment mixture. This material prevents chalking, insures color constancy and gives longer wear to paint. Zinc oxide has been used by the British Navy for half a century in battleship paint.

The rotating cylinders of many leading washing machines, now rapidly becoming a necessary adjunct to the American home, are made of rolled zinc. This material does not rust and therefore permits clothes being cleaned without discoloration.

Almost one-half of the compound of the best automobile tires on the market today is lead-free zinc oxide. This filler gives the tire its white color and resiliency and increases its tensile strength and durability.

Lithopone, a zinc product, is used in all flat wall finishes, wall paper and other interior decorations of the home. This material is also found in linoleum and table oilcloth, as well as being an important ingredient in surgical rubber goods and in certain hospital supplies.

According to wood-preserving experts, the railroads of the country could save 4c. each year on all ties they buy if these were treated before being placed in use. On one division of the Illinois Central in Kentucky ties treated with zinc chloride in 1903 are apparently still in almost perfect condition.

Zinc roofs have been in vogue in Europe for centuries. Their durability and the fact that zinc is a non-rusting material are qualities responsible for Europeans adhering to this type of covering for both their homes and for public buildings.

Book Reviews

THE PETROLEUM HANDBOOK. By *Stephen O. Andros, E. M.* 206 pp. 48 figs. 17 tables. Chicago: The Shaw Publishing Co. Price, $2.

While this book contains only a small proportion of original matter, it represents a careful and intelligent selection of fundamental data in regard to the petroleum industry. Facts and figures from twenty-seven standard works of reference have been brought together in the form of a connected, coherent résumé of this great industry.

The book is divided into eight chapters. The first discusses the origin, accumulation and occurrence of petroleum, the second the methods of exploration and drilling for oil and gas. Chapter III reviews briefly the methods of refining, giving flow sheets to illustrate the principal processes. Chapter IV describes the compression, refrigeration and absorption methods for the recovery of gasoline from natural gas. The shale oil industry is touched upon in Chapter V. Chapters VI and VII take up: The marketing of petroleum products in barrels, trucks and tank cars; gasoline specifications, inspection laws and marketing practices. A summary of the different state inspection laws relating to gasoline and kesosene is given in tabular form. The final chapter, "The Economic Utilization of Petroleum," illustrates the interrelation of the several factors previously discussed, in the working of a typical large progressive oil company.

Engineers, students and others interested in a brief yet accurate summary of the petroleum industry will welcome the appearance of this condensed reference book.

ALAN G. WIKOFF.

Personal

ADAM G. ADAMS, JR., who was until recently consulting engineer with the Nitrate Division of the Army Ordnance at Washington, has become affiliated with the Ashcraft-Wilkinson Co., of Atlanta, Ga., manufacturer and distributor of fertilizing materials.

A. V. BLEININGER, chief of the Ceramic Research Laboratory of the Bureau of Standards at Pittsburgh, has gone to Washington with his entire staff. A dinner and a large purse was given for Mr. Bleininger by his friends in Pittsburgh. The Ceramic Research Laboratory will be located in the new Engineering Building at the Bureau of Standards, Washington, D. C.

ELLERY K. FILES has become assistant superintendent of the pyroxylin department of the Duratex Co., Newark, N. J.

Dr. ZAY JEFFRIES will give fifteen lectures on non-ferrous metallography at the Graduate School, Harvard University, May 10 to June 1.

C. BRACE KELLY, formerly district manager of the American Sintering Co., Youngstown, Ohio, is now engineer for the American Ore Reclamation Co., with offices in New York.

E. G. REPPEL, general sales manager of the Buffalo Foundry & Machine Co., has spent a month touring the West. He left San Francisco April 24 by way of the Northwest for the East.

F. ROHDE has resigned as vice-president and general manager of the Palo Co., New York, to become president of the Rohde Laboratory Supply Co., recently incorporated.

FREDERICK J. RYAN has been elected president of the American Metallurgical Corporation, Philadelphia, Pa.

S. R. SCHOLES has severed his connection with the H. C. Fry Glass Co., Rochester, Pa., to become general manager of the Utility Glass Works, Lonaconing, Md.

Prof. ROBERT E. SWAIN of Leland Stanford University has been appointed by Federal Judge T. D. Johnson, commissioner to observe the operation of the smelters at Murray and Midvale, Utah, and investigate all complaints made as to smoke damage, reporting to the court on Feb. 1, 1921.

CLARENCE T. TODD, formerly with the Timber Butte Milling Co., is now with the engineering department of the Ray Consolidated Copper Co.

MAX ALBERT WHITING addressed the New York Electrical Society on Wednesday, April 21, on "Electricity in the Production of Iron and Steel."

ORVILLE WRIGHT is to be the recipient of the John Fritz Medal this year, at a meeting to be held in the auditorium of the Engineering Societies Building, New York City, May 7.

F. W. YOST, formerly engineer of the American Ore Reclamation Co., succeeds Mr. Kelly, resigned, as district manager of the American Sintering Co., Youngstown, Ohio.

Obituary

Dr. JOHN A. BRASHEAR, past president of the American Institute of Mechanical Engineers, died at his home in Pittsburgh, April 8, following a lingering illness.

O. J. D. THOMAS, late chief chemist of the E. B. Eddy Co., Hull, Canada, is dead of pneumonia. Mr. Thomas came from England some years ago, and, after spending some time in metallurgical work, engaged with the Eddy Co. in 1917.

Current Market Reports

The Non-Ferrous Metal Market

New York, April 26, 1920.—The domestic copper market remains quiet at 19¼c. for shipment up to August, with the outside market shading quotations to 18¾c., with a very little metal to offer. The quietude is probably very largely due to the railroad tie-up. It must also be taken into account that the Butte strike has greatly lowered the production of the refineries. Lead and zinc strengthened slightly, while silver continues to fall off in price. Another break in tin dropped the price to 61½c.

	Cents per Lb.
Copper, electrolytic	19.25
Aluminum, 98 to 99 per cent	32@33
Antimony, wholesale lots	11.25
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	61.50
Lead, New York, spot	9.00
Lead, E. St. Louis, spot	9.25
Zinc, spot, New York	8.75@9.00
Zinc, spot, E. St. Louis	8.45

OTHER METALS

Silver	oz.	$1.17⅝
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.50
Cobalt	lb.	1.50
Magnesium (f. o. b. Niagara Falls)	lb.	1.60
Platinum	oz.	142.00
Iridium	oz.	250.00
Palladium	oz.	142.00
Mercury	75 lb.	103.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	26.75
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	32.00
Seamless bronze tubing	34.50
Seamless high brass tubing	30.50

SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap	22.50 @24.50
Aluminum, sheet scrap	23.50 @24.50
Copper, heavy machinery comp	15.50 @16.00
Copper, heavy and wire	15.75 @16.00
Copper, light and bottoms	14.25 @14.75
Copper, heavy cut and crucible	16.25 @17.25
Brass, heavy	10.00 @10.25
Brass, light	8.50 @ 9.00
No. 1 clean brass turnings	10.00 @10.25
No. 1 comp. turnings	13.75 @14.25
Lead, tea	5.75 @ 6.00
Lead, heavy	7.50 @ 7.75
Zinc, scrap	5.00 @ 5.25

The Iron and Steel Market

Pittsburgh, Pa., April 23, 1920.

The course of the pig iron and steel markets has been uninteresting, the markets being extremely dull. Interest centers largely upon the curtailment in steel production and shipments caused by the rail strike and the possible effect such curtailment may have.

While the general accounts of the rail strike are very favorable as to the resumption of rail movement, it chances that the iron and steel industry has had but little relief thus far. While conditions East and West have improved materially, there is little improvement in the immediate Pittsburgh district and none in the valleys. There has been considerable improvement in the Chicago district, including Gary. The Pittsburgh gateway remains practically closed. The railroads are moving some perishables and foodstuffs, but not much even of such commodities. When it comes to commodities in which the iron and steel industry is interested, the railroads offer but little outside of suggestions that solid trainloads be made up, and there is question whether much of that sort of thing would prove successful.

Production Curtailed Less Than Expected

Production in the iron and steel industry, however, has not been curtailed to as great an extent as was expected or as was estimated early in the rail strike that began about a fortnight ago. While many blast furnaces are banked and not a few works are closed or are merely "limping along," there has been operation of many furnaces and plants by unexpected or devious means. Much Connellsville coke has been moved by water. Several lines of communication have been established over public roads, closed by the strike as to normal operation, but correspondingly open if shippers or consignees had locomotives and crews they could send out to use rails that would otherwise be idle. A few furnaces have been found with stocks of coke, accumulated during the several months of restricted transportation, when everyone took all the coke obtainable irrespective of requirements.

Even should the rail strike end entirely within a few days the curtailment in production would last for some time, as return of empties will undoubtedly be slow, and the total loss of production, in pig iron and steel, may amount to nearly if not quite a week's normal production by the whole industry.

Shipments Reduced More Than Production

Shipments of steel are reduced very much more than production. While the Youngstown mills are nearly all closed, the immediate Pittsburgh district is producing a fairly large tonnage, but has been shipping scarcely any. The largest local independent managed to gather a total of about 1,500 cars, which were loaded and have gone to railroad sidings or remain on company sidings, it becoming necessary then to pile steel on the ground. The Carnegie Steel Co. has been greatly aided in keeping its mills from being choked by having its own interplant line, the Union Railroad, as well as the Bessemer road, both of which have been in regular operation except for the moving of freight off their rails.

Consumers Are Indifferent

Curtailment in shipment has not brought the consumers into the prompt market to any extent. The indifference of consumers may be due to their being likewise restricted, in their operations, to a realization that prompt steel could hardly be secured by bidding for it, or to their having greater stocks that has been assumed. This last point raises an interesting question, for widely divergent views have been expressed of late as to the interpretation of the large output the industry has had in the past three months. One view was that the large output being absorbed so readily showed that the country had unexpectedly great absorbing power, the opposed view being that all the steel shipped was not consumed, but was to a considerable degree absorbed in stocks. Time may soon tell which was the correct analysis.

Whatever may be the state of order books or the position of the market at the moment as to the level of prices or the stiffness with which they are maintained, one cannot possibly contend that the position of the money and security markets disclosed by developments of the past few days is not an important factor in making or indicating the steel market's future. In the long run the steel industry, particularly when it is 40 or 45 per cent larger than just before the war, cannot have full employment for its capacity unless a large percentage of the output passes into works of permanent construction, into what may be called long term investments. Such investments certainly are not made when financial conditions are as at present. When the underwriters of 10-yr. 7 per cent gold bonds of the Pennsylvania R.R. can offer the bonds to the public at face, it is evident that investment construction generally cannot proceed on a high level of activity.

Steel Corporation Booked Far Ahead

Light on this general subject may be thrown by consideration of the state of steel mill order books. Several of the

large independent producers state that they have not formally opened their order books for third quarter shipments, though undoubtedly they have booked considerable tonnages, with large customers, for that period, while they will probably carry over some second quarter tonnages. The smaller independents, which are quoting much higher prices than the larger independents, are of course booked still less distances ahead. The Steel Corporation alone is booked far ahead, its average date being about Jan. 15, 1921, though of course this is merely an average, the various products being sold for widely different distances ahead. That the Steel Corporation is booked far ahead is merely a reflection of the fact that its prices are lower than those of the independents, and the further fact that its customers know that, in accordance with established practice in the steel trade, they would not be expected to take deliveries such as would work a distinct hardship to the buyer. The short distance ahead to which the independents are sold is significant. It might be thought that sales farther ahead could be effected by reducing prices, but such reductions would probably discourage buyers, and the policy of independents generally seems to be that, since they have attained certain price levels, it is better to adhere to them and let the trade buy for whatever distance ahead it chooses. It seems far from improbable that a general readjustment to a safer and saner condition in business generally is about to occur, and in any such adjustment the iron and steel industry will naturally have a part. Not a few bankers have predicted a crisis for next August, hence it is reasonably certain that no such thing will occur, for an expected crisis or panic is practically impossible. Either the event will not occur at all or it will be precipitated, for an earlier time, by the expectation.

Chemical and Allied Industrial Markets

New York, April 26, 1920.

General conditions throughout the list have not improved during the week; if anything the situation has become more serious than it has ever been before in the memory of those engaged in the trade. Spot material of the alkali group is being consumed faster than it arrives, producers are behind in their contracts on the heavy chemicals and all coal-tar products are practically nominal both on spot and contract. Shipments made just prior to the railroad strike are still en route and whatever material is on hand for the producer to ship is lying idle because of the lack of cars. Both foreign and domestic demand is very strong, as it has been for some time back, but owing to the above-mentioned conditions the volume of business has fallen off considerably.

PRINCIPAL PRICE CHANGES

	Today	Last Week	Last Month	Last Year
Aqua ammonia, 26 deg., lb.	\$0.08½-\$0.12	\$0.08½-\$0.12	\$0.08½-\$0.12	\$0.06½-\$0.09
Bleaching powder, cwt.	4.00 - 5.00	4.00 - 5.00	3.50 - 4.50	1.40- 2.00
Calcium chloride, fused lump, ton	22.00 -40.00	22.00 -40.00	20.00 -30.00	19.00 -20.00
Glauber's salt, cwt.	1.65 - 2.00	1.50 - 2.00	1.45 - 1.65	1.35 - 1.50
Salt cake, ton	21.00 -32.00	22.00 -26.00	21.00 -22.00	12.00 -14.00

General Chemicals

No new developments have occurred in this list, prices in general being sustained by the tightness of supplies. It is reported that producers are pretty well sold out on *calcium chloride* for future and the spot market is in a very poor way. The fused lump grade is firm at \$22@\$25 for car lots and \$30@\$40 per ton for less, while granulated came up slightly at 1½@2½c. per lb. Heavy demand on *carbon bisulphide* has tightened up. The spot market is short of supplies, and quotations vary from 9@10c. for spot, with the latter figure prevailing. Continued heavy demand both foreign and domestic has left producers in a bad way, being sold up for months ahead and unable to keep pace with contracts. The spot market is practically bare of material and as high as \$32 per ton has been heard, but the average seems to be between \$28@\$30 per ton. With the arrival of shipments of *sodium nitrite* from Norway the situation is easier. Spot material is 22@24c. per lb. *Nickel salts* has been under heavy inquiry during the week and former quotations of 14@15c. for double and 16@17c. per lb. for single are well maintained. *Soda ash* remains in the same nominal position, with quotations varying from \$3.50@\$4.50 for either grade, while export demand continues brisk and grasping at all available supplies. *Bleaching powder* is practically off the market, and figures as high as \$5 per cwt. have been heard during the week, but this cannot be considered the market, as there is so little material available that whatever does change hands is at a premium. The *acid* group is extremely short and business is being done on a small scale. *Hydrochloric* is wholly nominal, as there is very little material on hand. *Hydrofluoric* is in almost the same position and producers are reported sold ahead as far as three months. The 52 per cent grade is listed at 12@14c. per lb. *Oxalic* crystals under heavy demand has come up and is quoted at 55@57c. per lb.

Coal-Tar Products

Practically the same conditions prevailing throughout the chemical list exist also in tar products market. The spot shortages and transportation difficulties are possibly felt more acutely here than in any other market. There is practically no spot market on any of the items and producers are so much handicapped by the extremely heavy demand and the large decrease in production as not to be able even to conjecture when and how the situation may be made easier. *Beta napthol benzoate* remained firm, with difficulty in obtaining material. The previous listing of 50@65c. per lb. still holds. *Phthalic anhydride* is under the usual demand with one factor practically controlling the market price on this item. *Aniline oil*, under usual demand, held firm at 34@45c. with some difficulty in locating material at these figures. The *salts* are scarce on spot and 42@48c. per lb. is being asked.

Naval Stores

In naval stores the tight situation of extremely high prices, no material and heavy demand has not become any easier during the week. *Turpentine* still remains nominally quoted at \$2.50 per gal., but there is no material obtainable even at this level. *Rosins* are nominal also, as there is nothing to be had in either the New York or Savannah market. These conditions will remain until the arrival of the crudes at the primary market and until such time as the transportation problem can be made easier.

Vegetable Oils

Very little activity on the part of buyers of vegetable oils has been shown during the period and on the whole the market has been very weak. *Soya bean*, in barrels, slumped and is listed at 18@18½c., against 19@23c. per lb. of last week, and tanks at 13¾c. *Cottonseed* has been weak and dropped 1½c. to 16@17c. per lb.

Miscellaneous Materials

Barytes remains in the same nominal position as was previously reported. All quotations by producers are subject to conditions at the time of shipment. There is no spot material available. Quotations of \$38@\$40 for white floated and \$20@\$25 for off color per ton still hold.

The *feldspar* situation remains unchanged, with prices of \$13@\$18 for ground grade, f.o.b. New York State, well maintained.

Fluorspar, gravel, f.o.b. Tunuco, Mexico, is listed at \$25, while nominal prices of \$30@\$45 for acid grade lump, and \$52@\$57 per ton, for acid grade ground, f.o.b. Tunuco, still hold.

Ores and Semi-Finished Products

The Government price having been removed from coke, the price jumped from \$6 to \$11@\$12 for furnace and from \$7 to \$12@\$14 per ton on foundry. Due to the recent railroad strike, very little material has been moving from the Connellsville district, which makes listings practically nominal.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.60 – $0.65
Acetone	lb.	$0.13 – $0.15	.16 – .18
Acid, acetic, 28 per cent	cwt.	3.50 – 4.00	4.25 – 4.50
Acetic, 56 per cent	cwt.	8.00 – 8.50	8.75 – 9.00
Acetic, glacial, 99½ per cent. arboy	cwt.	15.50 – 16.00	16.50 – 17.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Citric	lb.	.85 – .86	1.17 – 1.18
Hydrochloric (nominal)	lb.	.08 –	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 –
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.05 – .05½	.06 – .07
Molybdic, C. P	lb.	–	4.25 – 5.00
Nitric, 40 deg	lb.	.07 – .07½	.07½ – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.55 – .57	–
Phosphoric, Ortho, 50 per cent solution	lb.	.24 –	–
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	16.00 – 18.00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	–
Sulphuric, 66 deg., drums	ton	32.00 – 33.00	–
Sulphuric, 66 deg., carboys	ton	34.00 – 35.00	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P	lb.	–	1.35 – 1.45
Tannic (tech.)	lb.	–	.60 – .80
Tartaric, crystals	lb.	–	.69 – .74
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal)	gal.	2.50 – 3.50	–
Alcohol, denatured, 188 proof (nominal)	gal.	–	1.00 – 1.05
Alcohol, denatured, 190 proof (nominal)	gal.	–	.98 – 1.02
Alum, ammonia lump	lb.	.04 – .05	.05½ – .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02½ – .03½
Aluminum sulphate, iron free	lb.	.02¾ – .03	.03¼ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08¾ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.08¾ – .12	–
Ammonium sulphate	lb.	.07 – .08	.08½ –
Amylacetate	gal.	–	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	–	.13½ – .14½
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	–
Barium chloride (nominal)	ton	–	165.00 – 175.00
Barium dioxide (peroxide)	lb.	.23 – .27	.28 – .30
Barium nitrate	lb.	.17 – .19	.20 – .22
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.05½ – .06
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.85 – .90	–
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	.06 – .06½	.07 – .07½
Calcium chloride, fused, lump	ton	22.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 – 4.25	4.35 – 5.00
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 – .80
Calcium sulphate, pure	lb.	–	.25 – .30
Carbon bisulphide	lb.	.07 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.11 – .11½	.12 – .15½
Carbonyl chloride (phosgene)	lb.	–	.80 – 1.05
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.07½ – .08	.08½ – .09
Chloroform	lb.	.29 – .30	.31 – .32
Cobalt oxide	lb.	–	2.00 – 2.05
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Formaldehyde, 40 per cent (nominal)	lb.	.38 – .40	.60 – .80
Glauber's salt (see sodium sulphate)		–	–
Glycerine	lb.	–	.24½ – .26
Iodine, resublimed	lb.	–	4.10 – 4.30
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	.14 – .14½	.15 – .18
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	–	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	–	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	3.40 – 3.55	3.60 – 4.25
Magnesium sulphate, commercial	100 lb.	3.00 – 3.10	3.10 – 3.25
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.16 – .17	.17½ –
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.36 – .37	.38 – .42
Potassium bitartrate (cream of Tartar)	lb.	.56 – .58	.59 – .61
Potassium bromide, granular	lb.	–	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.26 – .27	.28 – .30
Potassium chlorate, crystals	lb.	.15 – .16	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.30 – .35
Potassium iodide	lb.	–	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	–	$0.65 – $0.95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 –
Potassium prussiate, yellow	lb.	.34 – .36	.38 – .41
Potassium sulphate	ton	$225.00 – 240.00	–
Rochelle salts (see sodium potas. tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	28.00 – 32.00	–
Silver cyanide (nominal)	oz.	–	1.25 –
Silver nitrate (nominal)	oz.	–	.77 – .82½
Soda ash, light	100 lb.	–	3.50 – 3.60
Soda ash, dense	100 lb.	–	3.55 – 3.65
Sodium acetate	lb.	.08½ – .09	.09½ – .10
Sodium bicarbonate	100 lb.	2.45 – 2.60	2.75 – 3.00
Sodium bichromate	lb.	.40 – .41	.42 – .43
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.06 – .06½	.07 – .07½
Sodium borate (borax)	lb.	.08½ – .08¾	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.10 –	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	4.50 – 5.50	7.00 – 7.50
Sodium hyposulphite	lb.	–	.03 .04
Sodium molybdate	lb.	2.50 –	3.25½ –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.22 – .24	.24 – .25
Sodium peroxide, powdered	lb.	–	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.39 – .40	.40 – .41
Sodium prussiate, yellow	lb.	.23 – .z	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.65 – 1.70	1.75 – 2.00
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09 – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	–
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 – .50
Tin oxide	lb.	.60 – .63	.65 –
Zinc carbonate, precipitate	lb.	–	.19 – .20
Zinc chloride, gran.	lb.	.13 –	.13½ – .15
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.12¼ – .12½	.13 – .15
Zinc oxide, U. S. P.	lb.	–	.19 – .21
Zinc sulphate	lb.	.03½ – .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 — $1.10
Alpha naphthol, refined	lb.	1.40 — 1.60
Alpha naphthylamine	lb.	.40 — .50
Aniline oil, drums extra	lb.	.34 — .45
Aniline salts	lb.	.42 — .48
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.25 — 1.35
Benzidine, sulphate	lb.	1.20 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.10
Benzoate of soda, U.S.P.	lb.	.80 — 1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 — .36
Benzol, 90%, in drums (100 lb.)	gal.	.25 — .31
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate	lb.	.50 — .65
Beta naphthol, sublimed	lb.	.70 — .90
Beta naphthol, tech	lb.	.45 — .55
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.10
Cresylic acid, 95-97%, dark, in drums	gal.	.85 — 1.00
Cresylic acid, 50%, first quality, drums	gal.	.60 — .70
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.40 — 1.50
Dimethylaniline (nominal)	lb.	—
Dinitrobenzol	lb.	.30 — .37
Dinitroclorbenzol	lb.	.25 — .30
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.34 — .36
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.55 — .65
H-acid (nominal)	lb.	1.90 — 2.00
Metaphenylenediamine	lb.	1.15 — 1.80
Monochlorbenzol	lb.	.10 — .12
Monoethylaniline	lb.	1.70 — 1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.08 — .09
Naphthaline, flake	lb.	.09 — .10
Naphthaline, balls	lb.	.10½ — .11
Naphthionic acid, crude	lb.	.70 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.20 — .30
Ortho-amidophenol	lb.	3.75 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.25 — .45
Para-amidophenol, base	lb.	2.50 — 3.50
Para-amidophenol, HCl	lb.	2.50 — 3.25
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.00 — 1.35
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.60 — 3.00
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .25
Pyridin	gal.	2.00 — 2.50
Resorcin, technical	lb.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 — .52
Salicylic acid, U. S. P.	lb.	.55 — .60
Salol	lb.	.90 — 1.00

Solvent naphtha, water-white, in drums, 100 gal..	gal.	$0.25 — $0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19 — .24
Sulphanilic acid, crude	lb.	.25 — .30
Toluidine	lb.	1.70 — 2.50
Toluidine, mixed	lb.	.45 — .55
Toluol, in tank cars	gal.	.28 — .....
Toluol, in drums	gal.	.29 — .32
Xylidine, drums, 100 gal	lb.	.44 — .50
Xylol, pure, in drums	gal.	.37 — .45
Xylol, pure, in tank cars	gal.	.35 — .....
Xylol, commercial, in drums, 100 gal	gal.	.37 — .45
Xylol, commercial, in tank cars	gal.	.23 — .27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.38 — $0.39
Beeswax, refined, light	lb.	.40 — .41
Beeswax, white pure	lb.	.63 — .68
Carnauba, No. 1. (nominal)	lb.	.80 — .88
Carnauba, No. 2, regular (nominal)	lb.	.60 — .70
Carnauba, No. 3, North Country (nominal) . . . †	lb.	.45 — .46
Japan	lb.	.20 — .21
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	..... — .10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	..... — .11
Paraffine waxes, refined, 118-120 m.p.	lb.	..... — .10½
Paraffine waxes, refined, 128-130 m.p.	lb.	.12 — .12½
Paraffine waxes, refined, 133-135 m.p.	lb.	.14 — .14½
Paraffine waxes, refined, 135-137 m.p.	lb.	.16 — .16½
Stearic acid, single pressed	lb.	.26 — .27
Stearic acid, double pressed	lb.	.32 — .29
Stearic acid, triple pressed	lb.	.32 — .33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.65
Pine oil, pure, dest. dist	gal.	....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl	280 lb.	$18.50 — $19.50
Rosin E-I	280 lb	19.75 — 20.00
Rosin K-N	280 lb.	20.25 — 21.95
Rosin W. G.-W. W	280 lb.	22.00 — 24.00
Wood rosin, bbl	280 lb.	15.50 — 18.50
Spirits of turpentine	gal.	..... — 2.50
Wood turpentine, steam dist	gal.	2.35 — 2.40
Wood turpentine, dest. dist	gal.	..... — 2.00
Pine tar pitch, bbl	200 lb.	8.40 — 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50 — 15.00
Retort tar, bbl	500 lb.	15.00 — 15.50
Rosin oil, first run	gal.	.92 — .95
Rosin oil, second run	gal.	.94 — .97
Rosin oil, third run	gal.	1.10 — 1.15
Rosin oil, fourth run	gal.	1.17 — 1.18

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb	$0.40½ — $0.42
Upriver coarse	lb.	.30½ — .32
Upriver caucho ball	lb.	.32½ — .33
Plantation—First latex crepe	lb.	.43 — .44
Ribbed smoked sheets	lb.	.42¼ — .42½
Brown crepe, thin, clean	lb.	.42 — ....
Amber crepe No. 1	lb.	.40½ — .41½

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.19 — $0.20
Castor oil, AA, in bbls	lb.	.20 — .23
China wood oil, in bbls	lb.	.24 — .24½
Coconut oil, Ceylon grade, in bbls	lb.	.18½ — .19
Coconut oil, Cochin grade, in bbls (nominal)	lb.	.19 — .20
Corn oil, crude, in bbls	lb.	.17¾ — .18
Cottonseed oil, crude (f.o.b. mill)	lb.	.16 — .17
Cottonseed oil, summer yellow	lb.	.18½ — .19
Cottonseed oil, winter yellow	lb.	.21 — .23
Linseed oil, raw, car lots	gal.	1.84 — .....
Linseed oil, raw, tank cars	gal.	1.79 — .....
Linseed oil, boiled, car lots	gal.	1.87 — .....
Olive oil, commercial	gal.	2.75 — 3.00
Palm, Lagos	lb.	.15½ — .16½
Palm, bright red	lb.	.14½ — .17½
Palm, Niger	lb.	.14 — .17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.20½ — .22
Peanut oil, refined, in bbls	lb.	.25 — .26
Rapeseed oil, refined in bbls	gal.	1.65 — 1.66
Rapeseed oil, blown, in bbls	gal.	1.78 — 1.80
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	18 — 18½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.13¾ — .14½

FISH

Winter pressed Menhaden	gal.	$1.17 — $1.18
Yellow bleached Menhaden	gal.	1.20 — 1.22
White bleached Menhaden	gal.	1.23 — 1.24
Blown Menhaden	gal.	1.34 — 1.36

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$38.00 — $40.00
Barytes, off color	ton	20.00 — 25.00
Blanc fixe, dry	lb.	.04½ — .05½
Blanc fixe, pulp	ton	30.00 — 50.00
Casein	lb.	..... — ..
Chalk, English, extra light	lb.	.05 — .07
Chalk, English, light	lb.	.04½ — .06
Chalk, English, dense	lb.	.04 — .05
China clay (Kaolin), imported, lump	ton	25.00 — 35.00
China clay (Kaolin), imported, powdered	ton	30.00 — 60.00
China clay (Kaolin), domestic, lump	ton	10.00 — 20.00
China clay (Kaolin), domestic, powdered	ton	25.00 — 40.00
Feldspar (nominal) f.o.b. N. Y. State	ton	13.50 — 18.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, Mex.	net ton	30.00 — 45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00 — 65.00
Fuller's earth, domestic, powdered	ton	25.00 — 30.00
Fuller's earth, imported, powdered	ton	35.00 — 40.00
Graphite, crucible, 85% carbon content	lb.	...... — .07½
Graphite, crucible, 86% carbon content	lb.	...... — .08
Graphite, crucible, 87% carbon content	lb.	...... — .08
Graphite, crucible, 88% carbon content	lb.	...... — .09
Graphite, crucible, 89% carbon content	lb.	...... — .09½
Graphite, crucible, 90% carbon content	lb.	...... — .10
Graphite, crucible, 91% carbon content	lb.	...... — .10½
Graphite, crucible, 92% carbon content	lb.	...... — .11
Graphite, crucible, plus 92%	lb.	...... — .12½
Pumice stone, imported	lb.	.03 — .06
Pumice stone, domestic	lb.	.02½ — ....
Shellac, orange, fine . . . nominal	lb.	1.45 — ..
Shellac, orange, superfine	lb.	1.60 — 1.65
Shellac, A. C. garnet	lb.	1.30 — 1.35
Soapstone	ton	15.00 — 25.00
Talc, domestic	ton	20.00 — 30.00
Talc, imported	ton	60.00 — 70.00

*Nominal

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in	net ton	80-85 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 — $250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20 — .21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21 — .22
Ferro-manganese, 70-80% Mn	gross ton	180.00 — 250.00
Spiegeleisen, 16-20% Mn	gross ton	60.00 — 65.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25 — 2.75
Ferro-silicon, 50%	gross ton	80.00 — 90.00
Ferro-silicon, 75%	gross ton	150.00 — 200.00
Ferro-silicon, 10-15%	gross ton	60.00 — 65.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90 — 1.10
Ferro-uranium, 35-50%, of U	lb.	7.00 — .....
Ferro-vanadium, 30-40% per lb. of contained V	lb	6.50 — 7.75

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, C_2, O_3	unit	$0.70 — $0.85
Chrome ore, 48% and over	unit	1.00 — 1.25
Coke, foundry, f.o.b. ovens	net ton	12.00 — 14.00
Coke, furnace, f.o.b. ovens	net ton	11.00 — 12.00
Petroleum coke, refinery, Atlantic seaboard	net ton	..... — 14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00 — 30.00
Manganese ore, 45% Mn and over	unit	.75 — .85
Manganese ore, chemical (MnO_2)	gross ton	80.00 — 90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75 — .85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00 — 10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50 — 7.50
Uranium oxide, 96%	lb.	2.75 — 3.00
Vanadium pentoxide, 99%	lb.	5.00 — 7.00
Pyrites, foreign, lump	unit	.17 — .....
Pyrites, foreign, fine	unit	.17 — .....
Pyrites, domestic, fine	unit	.16 — .17½
Ilmenite, 52% TiO_2	lb.	.02 — .....
Rutile, 95% TiO_2	lb.	.11 — .....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75 — 3.00
Zircon, washed, iron free	lb.	.10 — .....
Monazite, per unit of ThO_2	unit	42.00 — .....

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

EL MONTE—The city rejected all bids for the installation of a septic tank in connection with the proposed sewer system, here. Olmsted & Gillilen, Hollingsworth Bldg., Los Angeles, Engrs. Work will be readvertised.

Connecticut

MIDDLETOWN—W. S. Miller, 37 Washington St., has awarded the contract for the construction of a 1-story, 40 x 70-ft. manufacturing plant addition on Washington St., to D. McKenzie, 17 Allison St. Estimated cost, $18,000.

NORWALK—Arnold & Co., Hoyt St., has awarded the contract for the construction of a 1-story, 50 x 100-ft. foundry, to M. J. Riordan, Hoyt St. Estimated cost, $30,000.

SHELTON—The city had plans prepared for the construction of a high school, here. A separate contract for installing a chemical laboratory in same will be sublet. Brown & Von Beren, 185 Church St., New Haven, Archts.

District of Columbia

WASHINGTON—The General Purchasing Officer of the Panama Canal will receive bids until May 5 for furnishing materials, including muriatic acid, oxalic acid, ethyl alcohol, aluminum sulphate, ammonia, barium sulphate, calcium chloride, chrome yellow, lampblack, white lead, mercuric oxide, yellow ocher, creosote oil, japan oil, linseed oil, putty, drop-black, paint, gum shellac, zinc dust, zinc oxide, etc.

Illinois

DANVILLE—The Interstate Water Co. plans to build an addition to its filtration plant here.

Indiana

INDIANAPOLIS—The Chapman Price Steel Co., 1970 Madison Ave., plans to rebuild the plant recently destroyed by fire. The plant will be converted into a rolling mill, which will be constructed on a 46 acre site south of Troy Ave. between Pennsylvania R.R. and Shelby St. Estimated cost, $1,000,000. Niles Chapman, Pres. and Treas.

INDIANAPOLIS—The Ft. Dodge Serum Co., Fort Dodge, plans to build a large hog and cholera serum plant, including 2-story buildings on West and McCarty Sts. Estimated cost, $150,000.

Iowa

WASHTA—The city has awarded the contract for the construction of a sewage disposal plant, to Frank Humphrey, Cherokee, at $13,400.

Kansas

OSAWATOMIE — The Missouri Pacific R.R. plans to construct a water treating plant, here. Estimated cost, $61,700. E. A. Hadley, 6061 Pershing Ave., St. Louis, Mo., Chief Engr.

PROTECTION — The city has awarded the contract for the construction of sewers and a sewage disposal plant, to Amerman & Snyder, Wichita, at $48,500. Noted April 7.

VALLEY FALLS—The Bd. Educ. will soon award the contract for the construction of a 2-story, 29 x 115-ft. and 38 x 54-ft. high school, here. A physical and chemical laboratory will be installed in same. Estimated cost, $62,000. E. E. Simpson, secy. W. E. Glover, 609 Kansas Ave., Topeka, Archt.

Kentucky

LOUISVILLE—The Mengel Box Co. is constructing a furniture panel factory on 10th St. and Ormsby Ave. Twelve large dry kilns will be built and a large 1-story warehouse will be converted into the factory proper. Estimated cost, $100,000. C. C. Mengel, pres.

Massachusetts

BOSTON — The Graphic Arts Printing Corp., 516 Atlantic Ave., plans to construct a 10-story, 150 x 268-ft. office building on Stuart St. Estimated cost, $300,000. Lockwood Greene Co., State St., Engrs. Derby & Robinson, 20 Beacon St., Archts.

HOLYOKE—The Hampden Glazed Paper & Card Co. plans to construct an addition to its present plant and raise one of its buildings one story in height. Estimated cost, from $100,000 to $125,000.

MITTENERGUE—The Strathmore Paper Co. has awarded the contract for the construction of a 5 story, 32 x 50-ft manufacturing plant addition, to D. O'Connell's Sons, 480 Hampden St., Holyoke. Estimated cost, $30,000.

Michigan

DETROIT — The Clayton-Lambert Co., 1380 Beaubien St., has awarded the contract for the construction of a 1-story, 210 x 300-ft. factory press building on Knodell Ave. and Detroit Terminal Ry., to the Wisconsin Bridge & Iron Co., 1362 Penobscot Bldg. Plans include a 1-story, 60 x 120 ft. foundry. Estimated cost, $322,000.

DETROIT—The Detroit Belt Lacer Co., 27 A St., is having plans prepared for the construction of a 1-story, 80 x 100-ft. heat-treating building on A St. Heat-treating furnaces will be installed in same. Estimated cost, $35,000. Louis Scisorek, 225 Farwell Bldg., Archt.

DETROIT—Albert Kahn, Archt., Marquette Bldg., will soon award the contract for the construction of a 1-story, 51 x 88-ft. foundry on Lafayette and Hastings Sts., for A. J. Detlaff, East Lafayette St. Estimated cost, $10,000.

HAMTRAMCK (Detroit P. O.) — The Swedish Crucible Steel Co., Butler St., is having plans revised for the construction of a 4-story, 100 x 200-ft. factory on Butler St., near the Grand Trunk Ry. Estimated cost, $200,000. Raseman & Freier, 1302 Penobscot Bldg., Detroit, archts.

MARYSVILLE—The Detroit Edison Co., David Whitney Bldg., Detroit, plans to build a gas plant on Bunce Creek Rd. Estimated cost, $200,000.

Minnesota

BERMIDJI—The Stellar Co., 922 2nd Ave. S., Minneapolis, plans to build a wood distillation plant, here, for the manufacture of turpentine. Estimated cost, $100,000.

Missouri

EXCELSIOR SPRINGS—The city is having plans prepared for the construction of a sewage disposal plant.

ST. JOSEPH—The St. Joseph Structural Steel Co. has awarded the contract for the construction of a 1-story, 100 x 180-ft. steel plant to the Lawlion Constr. Co. Estimated cost, $125,000.

ST. LOUIS, The Eureka Brass Co., 615-19 Red Bud St., has awarded the contract for the construction of a 1-story, 50 x 148-ft. foundry addition to the Fruin Colnon Contg. Co., Merchant Laclede Bldg. Estimated cost, $10,000.

WILLIAMSVILLE—The Midco Iron Co., Midco Carter Co., have leased several acres here and plan to construct an ore-washing plant on same. Estimated cost, $100,000.

New Jersey

KEARNY (Arlington P. O.) — The Bd. Educ. plans to construct a 3-story high school, here. A chemical laboratory will be installed in same. Estmated cost, $400,000. Guilbert & Betelle, 665 Broad St., Newark, Archts.

NEW BRUNSWICK—The State plans to construct a building for making ceramics. Estimated cost, $100,000. F. H. Bent, 142 West State St., archt.

TRENTON — The Mutual Potteries Co. plans to construct a new sanitary pottery building here. John A. Campbell, 379 West State St., pres.

New York

GLENFIELD—The Dexter Sulphite Pulp & Paper Co., Dexter, plans to build a large sawmill, here. Estimated cost, $100,000. Address, H. A. Long.

MIDDLETOWN—The Middletown Rubber Co., 5 Columbus Circle, New York City, plans to construct a 3-story rubber factory. Estimated cost, $500,000. Waldron & Van Winkler, 37 Wall St., New York City, Engrs.

NEW YORK—The Majestic Mills Paper Co., 464 Broome St., will alter a 6-story factory. Estimated cost, $25,000. Work will be done by day labor.

OSSINING—Charles F. Rattigan, supt. of prisons, Capitol, Albany, will receive bids until May 18 for the installation of duplicate solution type liquid chlorinating apparatus, etc., for the water supply system, at the Sing Sing Prison, here.

Ohio

CINCINNATI—The M. B. Farrin Lumber Co., Wenton Pl. Station, has awarded the contract for the construction of 1-story, 80 x 125-ft. dry kiln plant, to the Hazen Jones Co., 407 Johnson Bldg. Estimated cost, $30,000.

CLEVELAND—The Superior Fdry. Co., East 71st St. and the Wheeling and Lake Erie R.R., has awarded the contract for the construction of a 2-story, 60 x 200-ft. foundry, to the Sam W. Emerson Co., 1900 Euclid Ave. Estimated cost, $100,000.

CLEVELAND — The Virdon Mfg. Co., Ashland Rd., manufacturer of brass spinners, is having plans prepared for the construction of a 1-story, 40 x 92-ft. factory addition on Ashland Rd. and Longfellow Ave. Estimated cost, $60,000. J. E. Virdon, pres. Ernest McGeorge, 1900 Euclid Ave., archt. and engr.

CUYAHOGA FALLS—The Falls Rubber Co. is having plans prepared for the construction of a 3-story, 61 x 84-ft. factory addition. Estimated cost, $100,000. Ernest McGeorge, 1900 Euclid Ave., Cleveland, archt.

DAYTON—The A.-C. Electrical Mfg. Co., U. B. Bldg., plans to build a 2-story, 100 x 250-ft factory for the manufacture of electrical appliances on East 4th St. Estimated cost, $150,000.

NORWOOD—The G. A. Gray Co., Gest and Depot Sts., Cincinnati, plans to build a factory for the manufacture of metal planers, on Edwards and Edmondson Aves. Estimated cost, $1,500,000.

RAVENNA—The McElrath Tire & Rubber Co., 1836 Euclid Ave., will receive bids until May 1 for the construction of a 1 and 2-story, 100 x 300-ft. factory and 30 x 50-ft. boiler house. Estimated cost, $125,000. P. J. McElrath, pres. Donald C. Smith, Lennox Bldg., Cleveland, architect and engineer.

RAVENNA—The Oak Rubber Co. has awarded the contract for the construction of a 2-story, 60 x 180-ft. rubber factory, to the P. S. Frank Co. Estimated cost, $60,000.

TOLEDO — The Grasselli Chemical Co., c/o S. Gronemeyer, Guardian Bldg., Cleveland, is having preliminary plans prepared for the construction of a 1-story chemical plant. Estimated cost, $300,000.

Oklahoma

CLINTON — The State Bd. of Affairs, Oklahoma City, is receiving bids for the construction of a water supply line, electric pole line and a sewage disposal plant. E. J. Peters and A. M. Jenkins, Shawnee, archts.

GRANDFIELD — The Bd. Educ. has awarded the contract for the construction of a 2-story high school, here, to W. E. Corlett, Vinita. A chemical laboratory will be installed in same.

Pennsylvania

DICKSON CITY—The Early Foundry Co. plans to construct a 38 x 90 x 200-ft. foundry on the Main Rd. Foundry equipment will be installed in same. Total estimated cost, $200,000.

ERIE—The city plans to vote on $1,300,000 bond issue for various city improvements, including sewers and a sewage disposal plant, etc., to cost $333,000. F. Hanlon, city clk.

HARRISBURG—The Bd. Educ. is having plans prepared for the construction of a senior high school on 6th and Division Sts. A chemical laboratory will be installed in same. Plans also include a foundry, machine shop, physics laboratory, etc.

LOCK HAVEN—The city has awarded the contract for the construction of a 2-story, 300 x 500-ft. paper mill, to the Turner Construction Company. Estimated cost, $2,000,000.

Rhode Island

CENTRAL FALLS (Pawtucket P. O)—The United Nets Corp., 229 4th Ave., New York City, is having plans prepared for the construction of a 2-story dyehouse and bleachery on High St. Estimated cost, $20,000. Clark, McMullen & Riley, 101 Park Ave., New York City, Archts. and Engrs.

Tennessee

ALTON PARK—J. F. Hager, mayor, and the city comrs. will receive bids until May 8 for the construction of a system of sanitary sewers, consisting of septic tank, flushing tanks, etc.

MEMPHIS—The Maury-Cole Co., 462 South Wagner St., plans to install new machinery in the existing plant for the preparation of peanut products.

Texas

HOUSTON—The Macks Mfg. Co., Ltd., Mack St., is building extensions to its present extensive factory, here, including a 74x200-ft. steel foundry equipped with a 3-ton electric furnace, core ovens and other equipment. Charles R. Edwards, supt.

WHITESBORO—The Whitesboro Oil & Refining Co. has awarded the contract for the construction of a 2,000-bbl. daily capacity oil refinery, to Earl & Beck, St. Louis, Mo. Estimated cost, $150,000.

West Virginia

PARSONS—The O. A. Miller's Chemical Co. is in the market for bottle filling, labeling and corking machines, filters, mixing tanks, etc.

Wisconsin

CUDAHY—The Federal Rubber Co., Packard Ave., has awarded the contract for the construction of a 6-story, 100x120-ft. rubber mill, to the Leonard Constr. Co., 332 South Michigan Ave., Chicago.

MILWAUKEE—The Bernert Mfg. Co., 489-91 12th St., has purchased an 8-acre site on Atkinson Ave., North Milwaukee, and plans to build a 120x260-ft. building and a 60x100-ft. foundry on same. Joseph Glaser, archt.

MILWAUKEE — The Lindemann & Hoverson Co., 1st and Cleveland Aves., is having plans prepared for the construction of a 1-story, 60x80-ft. annealing plant on 1st Ave. Estimated cost, $25,000. Klug & Smith, Mack Bldg., engrs.

MARINETTE—The Hoskins-Morainville Paper Co. has awarded the contract for the construction of a mill, here, to the H. J. Selmer Constr. Co., Green Bay. The mill will include a 2-story, 63x80-ft. main building, a turbine house, power house and stack. Estimated cost, $350,000.

SHEBOYGAN—The Badger State Tanning Co., South Water St. and Maryland Ave., has awarded the contract for the construction of a 4-story, 105x342-ft. tannery, to the Westinghouse, Church, Kerr Co., Inc., 37 Wall St., New York City. Estimated cost, $750,000. Noted Jan. 21.

SHEBOYGAN—The Rexire Co., South River St., plans to build a 4-story, 60x200-ft. factory and an addition to present factory for the manufacture of soaps and oils. Estimated cost, from $45,000 to $50,000.

Ontario

ESSEX—The Essex Traction Co. plans to construct a 1- and 2-story addition to its factory for the manufacture of traction engines. Estimated cost, $50,000.

LONDON—The Bd. Educ. plans to build a school building, here. A chemical and physical laboratory with complete equipment will be installed in same. Estimated cost, $175,000. L. E. Carrothers, archt.

OTTAWA—The Dept. of Pub. Wks. will soon receive bids for the construction of a 4-story research institute for the Dominion Government. Scientific instruments will be installed in same. Estimated cost, $500,000. R. C. Knight, archt.

OTTAWA—The Nukol Fuel Co., Ltd., 198 Sparks St., will soon have plans prepared for the construction of a factory for the manufacture of nukol. Estimated cost, $250,000.

SARNIA—S. B. Coon & Son, archts., 36 Toronto St., Toronto, will receive bids until May 5, for the construction of a 3-story high school, here, for the Bd. Educ. Chemical and physical laboratory equipment will be installed in same. Estimated cost, $325,000. Melvern F. Thomas, 229 College St., Toronto, engr.

TORONTO—The Canadian Tygard Engine Co., Kingston Rd., has awarded the general contract for the construction of a 2-story, 50x160-ft. factory for the manufacture of carburetors and engines, to Walter Smelling. Estimated cost, $40,000.

TORONTO—The Dominion Oxygen Co., 120 Elm St., has awarded the contract for the construction of a 3-story, 60x80-ft. liquid oxygen plant on Elm St., to Wells & Gray, Confederation Life Bldg. Chemical equipment for oxygen generation will be installed in same. Estimated cost, $75,000.

TORONTO—The Photo Engravers Ltd., 70 Bond St., has awarded the general contract for the construction of a 3-story, 60x80-ft. photo engraving building, to T. E. Essery, Confederation Life Bldg., at $80,000.

WOODSTOCK—The city has awarded the contract for the installation of filtros plate, in connection with the proposed sludge plant, here, to the General Filtration Co., Cutler Bldg., Rochester, N. Y., at $4,551.

Quebec

MURRAY BAY—The Murray Bay Power and Pulp Co. plans to construct a plant here. Estimated cost, $500,000.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its sixth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CHEMICAL SOCIETY, N. Y. Section, will hold regular meetings on May 7 and June 11, at the Chemists' Club.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18, inclusive.

THE AMERICAN ZINC INSTITUTE will hold its spring meeting May 10 and 11 at the Congress Hotel, Chicago, Ill.

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK announces the following lectures for the spring semester of 1920 to be delivered in the Doremus Lecture Theater: "Modern Coke and Gas Manufacture" (Koppers process), Thursday, April 29, at 4 p.m., E. L. Crowe (*Lantern and cinema*); "Chemical Naval Warfare," Friday, May 7, at 4 p.m., Prof. James Kendall, professor of chemistry at Columbia University; "Fighting Fire—Firefoam," Friday, May 14, at 4 p.m., F. A. Epps, chief engineer, the Foamite Firefoam Co. (*Experimental, cinema and lantern.*)

THE INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA plans to hold its annual convention in the Auditorium Theater, Chicago, Ill., May 19, 20 and 21.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E., will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect. The autumn meeting of the Iron and Steel Institute (British) will be held at Cardiff, by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE MINE INSPECTORS' INSTITUTE OF AMERICA will hold a meeting at Cleveland, Ohio, July 13, 14 and 15.

THE MINING SOCIETY OF NOVA SCOTIA has planned a meeting for May 4 and 5 which will be held in Glace Bay.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 and 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE NEW JERSEY CHEMICAL SOCIETY plans the following: Monday evening, May 10, regular meeting; Saturday afternoon and evening, June 5, at Rutgers College, New Brunswick, N. J., regular meeting and ladies' day.

THE SOCIÉTÉ CHIMIE INDUSTRIELLE will hold a meeting at the Chemist's Club, May 14.

THE SOCIETY OF COTTON PRODUCTS ANALYSTS will hold its eleventh annual convention at the Grunewald Hotel, New Orleans, La., May 10 and 11.

THE SOCIETY OF CHEMICAL INDUSTRY, American Section, will hold a meeting, May 21, at the Chemists' Club.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

Industrial Notes

C. C. MCDERMOTT has succeeded J. W. Lazear as district manager of the Chicago office of the Brown Instrument Co. of Philadelphia. Mr. McDermott has been transferred from the Philadelphia office, where he was district manager for some time.

THE CHICAGO PNEUMATIC TOOL CO. transferred its general office from Chicago to New York City on March 31. The new quarters of the company are in a 10-story structure erected for its exclusive use at 6 East 44th St. At the same time the Chicago district sales branch, formerly in the Fisher Bldg., was moved to 300 North Michigan Boulevard. The Chicago service branch, formerly at 521 South Dearborn St., has been consolidated with the sales branch at the new address, where both are under the direction of J. S. Canby, district manager.

THE YARNALL-WARING CO., Philadelphia, announces that D. T. Newman, formerly connected with the Philadelphia sales office, has been placed in charge of its Atlanta, Ga., office, recently opened in the Candler Annex.

THE COOPER UNION FOR THE ADVANCEMENT OF SCIENCE AND ART, New York City, announces a new day course in industrial chemistry opening Oct. 4, 1920. The course will cover a period of four years. It is intended that the instruction provided shall be eminently practical and thoroughly scientific and that it will furnish adequate equipment for young men and women who desire employment as analysts, production foremen, research chemists, engineers, factory superintendents, purchasing agents, and in other phases of industry which call for persons with chemical training.

THE TABER PUMP CO., Buffalo, N. Y., maintains a resident representative in Chicago in the person of G. T. Schushan, with office at 410 Cunard Bldg.

THE PLAN FOR THE MERGER of Westinghouse, Church, Kerr & Co., Inc., and Dwight P. Robinson & Co., Inc., recently submitted for the approval of the stockholders of these companies, has been declared operative by the committee appointed in accordance with plan. At a meeting of the board of directors of Westinghouse, Church, Kerr & Co., Inc., Dwight P. Robinson was elected president of that company, pending final completion of the merger and organization of the new company. General Guy E. Tripp, now chairman of the board of Westinghouse, Church, Kerr & Co., Inc., retains this position pending completion of the merger. The Westinghouse Electric & Manufacturing Co. is one of the largest stockholders of Westinghouse, Church, Kerr & Co., and the two companies have been closely identified for many years. To avoid what has seemed a handicap in procuring business by the latter company, on account of the belief by prospective clients that if they employed it as their construction engineer, they might be expected to purchase Westinghouse electric equipment, and also to permit the Westinghouse Electric & Manufacturing Co. to withdraw from any

interest in the engineering and construction business, it was deemed in the interest of both companies that the association should be terminated. To accomplish this without embarrassment to other stockholders, and to their advantage, negotiations were initiated with Dwight P. Robinson, president of Dwight P. Robinson & Co., Inc., looking to a merger of Westinghouse, Church, Kerr & Co. with Dwight P. Robinson & Co., Inc. These negotiations resulted in the plan of merger now declared operative, under which depositing stockholders will receive for their present holdings either cash or stock in the new company.

THE RESEARCH CORPORATION announces the removal of its offices to 31 West 43rd Street, New York.

THE ELECTRO-ALLOYS Co., Elyria, Ohio, has been formed to take over and manufacture certain alloys developed by F. A. Fahrenwald. The initial product will be chiefly a high-temperature alloy in the form of heat-treating and other apparatus requiring resistance to oxidation at high temperatures. These high-temperature products will be marketed under the trade name—"Thermalloy." The electric foundry will be in operation about May 1.

THE BARBER-GREEN Co., Aurora, Ill., has found it necessary to make certain additions and changes in its selling organization due to the rapid growth of the company and the demand for B-G self-feeding bucket loaders and standardized belt conveyors. It is represented in St. Louis by R. E. Foulke, 404 Third National Bank Bldg.; in Pittsburgh by J. A. Gurney, 605-606 Arrott Bldg.; in Philadelphia by F. S. Sawyer, 1010 Penn Square Bldg.; in Indianapolis by W. T. MacDonald, 305 Merchants Bank Bldg.

THE ROVEY INSTRUMENT & CHEMICAL CO. has been incorporated in Buffalo, N. Y., by George G. Stuart, of Cleveland, Ohio, district salesmanager for the Youngstown Sheet & Tube Co., John S. Rovey, former purchasing agent for the Buffalo Apparatus Co., and Mrs. James M. Gisel, with a capital stock of $25,000. The concern is located at 75 Niagara Sq., Buffalo, N. Y. For the present it will act as sales agent, although Mr. Rovey announces that it is the idea of the incorporators to engage in the manufacture of industrial and commercial and laboratory instruments.

THE PHILADELPHIA TEXTILE MACHINERY Co., Philadelphia, Pa., announces its change of name to Proctor & Schwartz, Inc. The change is in name only, as the management, finances, policies, etc., remain as before.

WHEELER & WOODRUFF, chemical engineers, 280 Madison Ave., New York, announce the opening of a research and chemical engineering laboratory at 236 East 151st St., New York. The following chemical engineers and chemists have recently joined the organization: James F. Walsh, chemical engineer, lately Lieutenant in the Chemical Warfare Service, in charge of the charcoal development at the Astoria plant of the Gas Defense Division. Before entering the service Mr. Walsh was employed as chemist by the Goldschmidt Co., the Bosch Magneto Co., Borden's Condensed Milk Co. and the Otis Elevator Co. George Urquhart, chemical engineer, lately Captain in the Chemical Warfare Service, assigned to the chemical manufacture and development section of the Gas Defense Division. Before entering the service Mr. Urquhart was employed by the Solvay Process and Semet-Solvay companies at Syracuse, N. Y. William A. Jarrett, chemist, lately Lieutenant in Infantry, U. S. Army. Before entering the service Mr. Jarrett was employed as chemist by the Horton Ice Cream Co., New York. Walter C. Spiess, chemist, lately in the Gas Defense Division of the Chemical Warfare Service. Before entering the service Mr. Spiess was employed as chemist by Baker & Co., Inc., Newark, N. J.

THE METAL & THERMIT CORPORATION, New York City, N. Y., in order to more adequately take care of its rapidly increasing business in the New England States and in Canada, has appointed James G. McCarty manager of its Canadian branch, with headquarters in Toronto, and has transferred Robert L. Browne from its New York office to Boston, where he will have charge of all sales in the New England States.

THE STEPHENS-ADAMSON MFG. Co., Aurora, Ill., announces the opening of a new branch store, assembling shops and sales office at 412 East Third St., Los Angeles, Cal. This office will be under the direction of R. C. Pierce.

JOSEPH T. RYERSON & SON of Chicago and New York, and the Camden Iron Works, Camden, N. J., announce a new selling arrangement whereby Joseph T. Ryerson & Son become representatives of the Camden Iron Works in the sale of its hydraulic machinery products. Joseph T. Ryerson & Son have been in business for the past seventy-eight years, with their main warehouse plant and general office at Chicago, branch plants at New York, Buffalo, Detroit and St. Louis, and sales offices in the larger cities in the United States. They also have a foreign selling organization, with representatives in Europe and the Orient. The Camden Iron Works is also an old-established manufacturing concern, and in addition to a complete line of hydraulic tools, is a builder of centrifugal pumps, cast-iron pipe and fittings, gas holders and kindred products.

THE NITRATE AGENCIES Co., a subsidiary of W. R. Grace & Co. of New York, is building a $250,000 plant at Bergen Point, Bayonne, N. J., for the manufacture of dyes, disinfectants, intermediate and spraying materials. The four-story building will be of hollow tile, reinforced-concrete construction, with 36,000 sq.ft. capacity. An additional warehouse of 20,000 sq.ft. floor space is also planned. The Elliott C. Brown Co. of New York has the contract for erecting the plant. Production and sales department will be in charge of Mr. Goulard. Dr. Joseph L. Turner is the technologist. The plant is expected to be in operation next September.

H. H. HARRIS, formerly general sales manager for the Swedish Crucible Steel Co., has been appointed manager for the department of heat-treating equipment of the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City.

THE SOUTHERN LABORATORY SUPPLY CO., which has opened offices and warehouse in Birmingham, Ala., is the first laboratory supply house to locate in the South. For years the need of such an institution has been apparent and the establishment of this pioneer enterprise in Southern territory has met with the approval of the business and industrial interests of this section. The executive heads of the compay are Charles W. Hogg, president, and George B. Meanor, Jr., vice-president, both formerly of Pittsburgh, Pa.

THE THERMAL SYNDICATE, LTD., New York City, announces that W. Earle Strevig, formerly of the New York office, is now its Pittsburgh-Cleveland representative. He can be reached at 71 Crafton Ave., Crafton, Pa.

THE GUARANTEE BATTERY CORPORATION, of 1830 Blake St., Denver, Col., has recently been organized for the manufacture of automobile storage batteries. A part of the plant is already operating in the capacity of thirty-six batteries per day. This will be increased to eighty-five about May 1. George W. Brayfield is president, and Harry C. Brayfield secretary-treasurer. Earl B. Gandy is general manager and director of sales.

WILLIAM M. TAYLOR announces the formation of the HAMMOND INDUSTRIAL LABORATORIES, with offices at 80 Maple St., Hammond, Ind. These laboratories will specialize in the purification of water for industrial purposes and in the analysis of tanning materials. Mr. Taylor has been chemical engineer for the Kenicott Co., chemist for Montgomery, Ward & Co., chief chemist for the Refinite Co. of Omaha, and of Paige & Jones Chemical Co. of New York and Hammond, Ind.

THE NATIONAL LUMBER MANUFACTURERS ASSOCIATION has removed its general offices to the McCormick Bldg., 332 South Michigan Ave., Chicago, Ill.

WALLACE & TIERNAN CO., INC., manufacturer of chlorine control apparatus for water and sewage purification and industrial uses, announces that Harold S. Hutton has been appointed district sales representative with headquarters in the Commonwealth Bldg., Pittsburgh, Pa. Mr. Hutton succeeds P. O. Collins, who has been given indefinite leave of absence on account of illness.

D. R. SPERRY & CO., manufacturers of filter presses at Batavia, Ill., have added a department to the factory, which is turning out filter cloth and fabric, and are now prepared to ship either sewed cloth or rolls. This company also has added to the foundry equipment, which is now double its former capacity.

THE CHICAGO ASSOCIATION OF COMMERCE has organized a convention bureau, with headquarters at 10 So. LaSalle St., which will function to procure hotel accommodations for business men visiting the city as well as those desiring to stay over long periods. Crowded conditions during convention periods will be obviated.

THE MORSE CHAIN CO., Ithaca, N. Y., has moved its offices from Greensboro, N. C., to 404 Commercial Bank Bldg., Charlotte, N. C. George W. Pritchett, Southeastern manager, has found this change advisable owing to the increase in use of Morse silent chains in the textile industry.

Manufacturers' Catalogs

THE AUTOMATIC PRIMER CO., 420 Conway Bldg., Chicago, Ill., has just issued a leaflet describing a new automatic primer for centrifugal pumps.

THE CALORIZING CORPORATION OF AMERICA, Detroit, Mich., has issued a handsomely illustrated booklet, "The Protection of Metals from Oxidation at High Temperatures," which deals with protective coatings, the development and application of calorizing, and contains an appendix of useful tables. The de luxe edition is bound in flexible leather and shows a colored scale for heat measurement.

THE ELECTROLABS CO., Pittsburgh, Pa., is issuing a pamphlet on Levin Oxy-Hydrogen cells. It also announces that it offers complete plants for the production, distribution, compression and utilization of oxygen and hydrogen gases, and can, through its own manufacture supply all the necessary accessory equipment. Actual photographs of plants in operation and letters from manufacturers are included.

THE NORTON CO., Worcester, Mass., has issued three booklets, entitled "How to Order Grinding Wheels," "Grinding Wheel Stands in the Machine Shop," and "The Norton Razor Hone."

THE H. S. B. W. COCHRANE CORP., Philadelphia, Pa., formerly the Harrison Safety Boiler Works, has issued a book describing the hot process water softener. The hot process softener is a modern development of the well-known lime-soda process, the difference being that the chemicals are added to the water only after it has been heated to 205 deg. F. or higher, which results in practically instantaneous and complete chemical reactions and in more rapid settlement of the precipitate. The result is a considerable reduction in the time required for the sedimentation so that the apparatus can usually be installed within power plant buildings and without requiring special foundations or housing. The fact that a feed water heater is combined as part of the apparatus also reduces the complication and the expense of piping, etc. It is also claimed that the maximum reduction of scale- and sludge-forming matter is obtained with a minimum excess of reagents and that there is no after-precipitation or troublesome deposits of scale and sludge in pumps, piping, feed-water heaters and boilers, while, due to the reduced solubility of the products in hot alkaline water, the minimum amount of sludge-forming solids enter the boiler and the tendency to priming and foaming is minimized. In the present publication these statements are supported by scientific data and by the results of practical operation. An improved type of a chemical feeder designed to force the water into the softener against back pressure, and a system of pressure filters, are also described. The closing chapter enumerates the impurities found in boiler-feed water and describes the kinds and amounts of chemicals necessary for their removal. The book will be of value to all who are concerned with the operation of steam boilers.

THE CELITE PRODUCTS CO., 11 Broadway, N. Y., is issuing an interesting bulletin known as B-6a, describing the insulation construction of different types of boilers. The bulletin is illustrated with diagrams and views of various installations.

THE DEISTER CONCENTRATOR CO., Fort Wayne, Ind., calls attention to its latest catalog, No. 5, illustrating and describing the Deister-Overstrom diagonal deck tables.

THE AMERICAN STEAM CONVEYOR CORP., Chicago, Ill., is distributing a catalog entitled "The American Trolley Carrier," which is an economical one-man method of handling coal ashes and like material. The equipment consists of an overhead trolley, operated on either a monorail track or suspension cable. A hoist is used to lower and move a 7-ton, self-dumping bucket, in which the material is carried. One man handles the carrier in all its operations—loading, hoisting, conveying, dumping and returning the bucket. He is not obliged to leave his station at the hoist at any time. An average of 30 tons of coal can be handled an hour. Five or six cars can be emptied during the day. The cost per ton of coal handled is extremely small, 3c. or 4c. as contrasted with the usual 18c. or 20c. entailed. Copies will be sent to interested readers on request.

THE BARNSTEAD STILL & STERILIZER CO., Boston, Mass., and Chicago, Ill., has issued a catalog on Barnstead patent water purifier and still.